United States
Department of
Agriculture

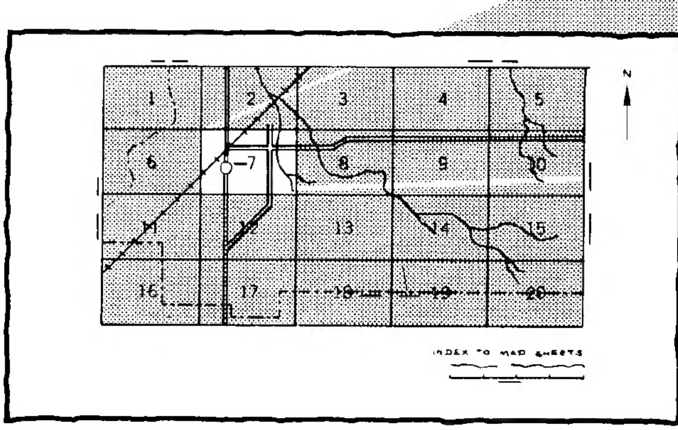
Soil
Conservation
Service

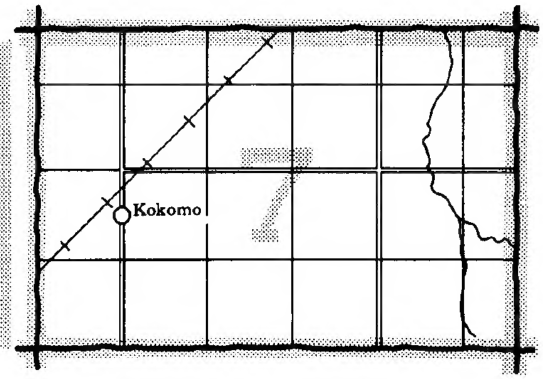
In cooperation with
the Forest Service and
the Michigan Agricultural
Experiment Station

Soil Survey of Lake and Wexford Counties Michigan

HOW TO USE

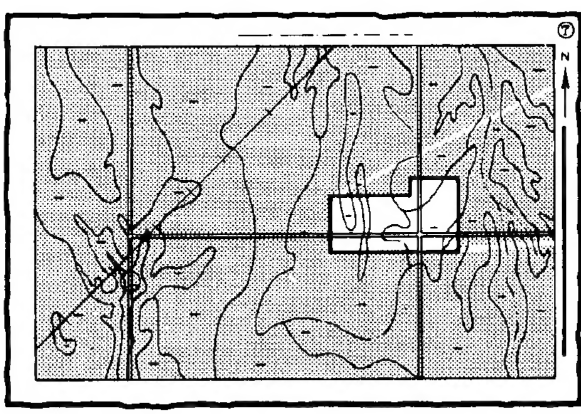
1. Locate your area of interest on the "Index to Map Sheets."

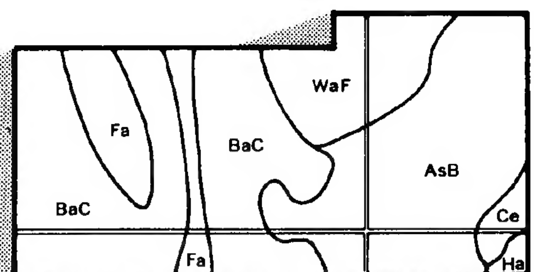




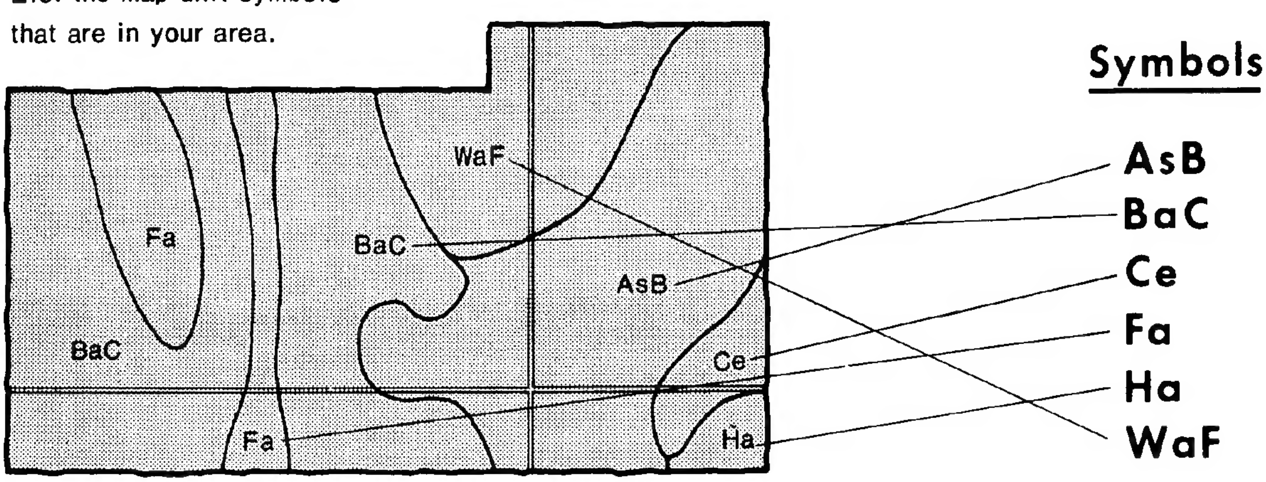
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



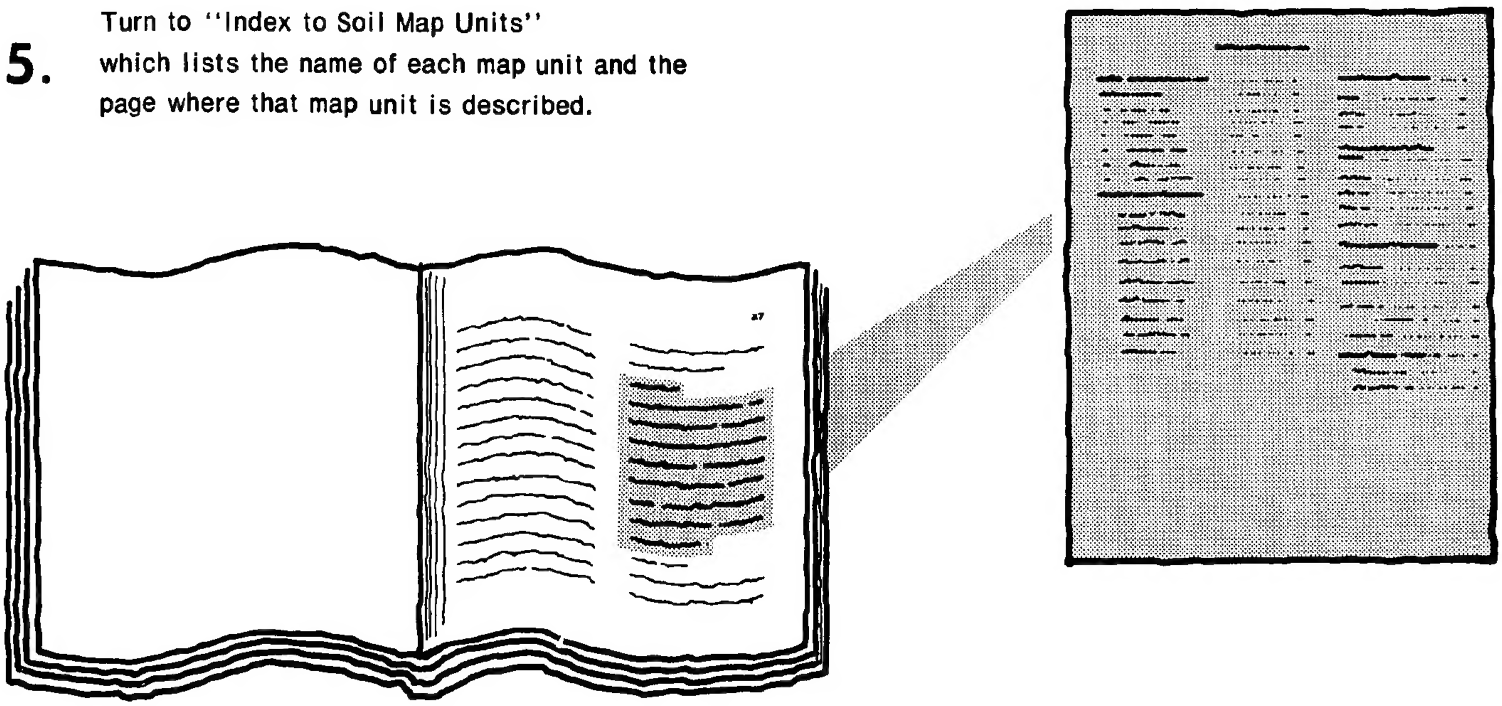


4. List the map unit symbols that are in your area.

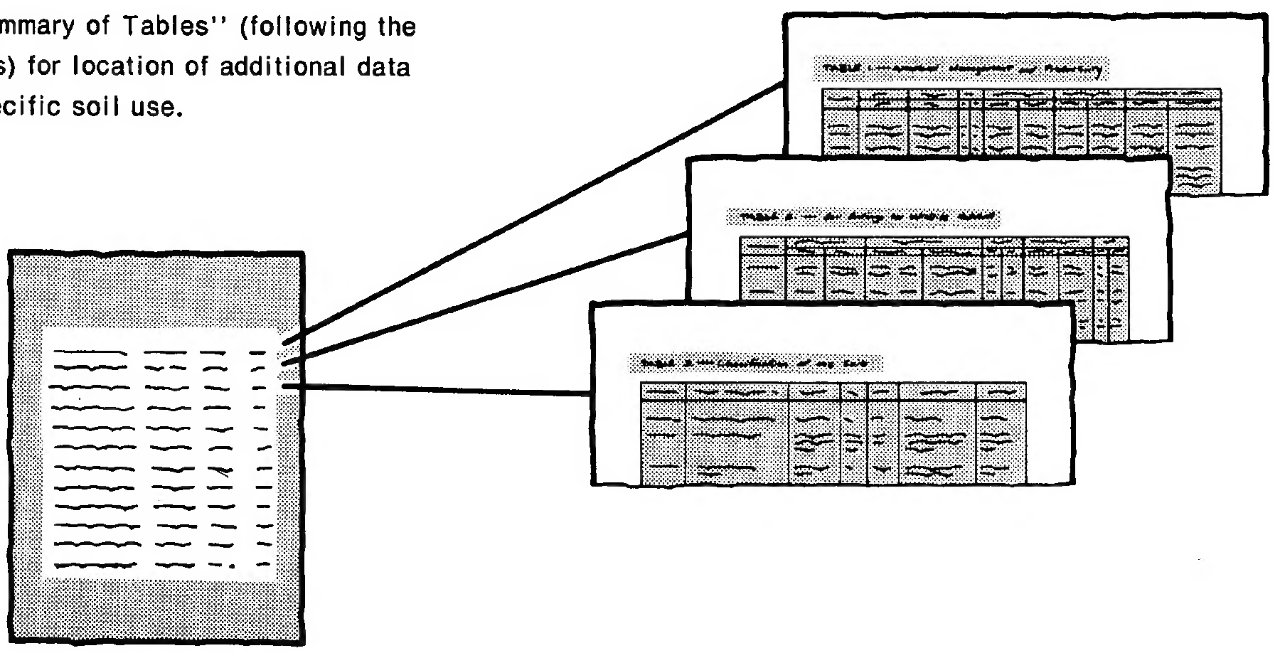


THIS SOIL SURVEY

5\. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6\. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7\. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1982. Soil names and descriptions were approved in 1982. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1982. This survey was made cooperatively by the Soil Conservation Service, the U.S. Forest Service, and the Michigan Agricultural Experiment Station. It is part of the technical assistance furnished to the Mason-Lake Soil Conservation District, the Osceola-Lake Soil Conservation District, and the Wexford County Soil Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Canoeing on the Pere Marquette River. Three rivers in the area—the Manistee, the Pine, and the Pere Marquette—all provide excellent and scenic canoe trails.

Contents

Index to map units ... iv
Summary of tables ... v
Foreword ... vii
General nature of the survey area ... 1
How this survey was made ... 4
General soil map units ... 7
Soil descriptions ... 7
Detailed soil map units ... 13
Soil descriptions ... 13
Prime farmland ... 39
Use and management of the soils ... 41
Crops and pasture ... 41
Woodland management and productivity ... 44
Windbreaks and environmental plantings ... 46
Recreation ... 46
Wildlife habitat ... 48
Engineering ... 49
Soil properties ... 55
Engineering index properties ... 55
Physical and chemical properties ... 56
Soil and water features ... 57
Characterization data for selected soils ... 58
Classification of the soils ... 59
Soil series and their morphology ... 59
Formation of the soils ... 73
Factors of soil formation ... 73
References ... 77
Glossary ... 79
Tables ... 87

Soil Series

Allendale series ... 59
Au Gres series ... 60
Croswell series ... 61
Dighton series ... 61
East Lake series ... 62
Emmet series ... 62
Finch series ... 63
Graycalm series ... 63
Grayling series ... 64
Hodenpyl series ... 64
Kalkaska series ... 65
Karlin series ... 65
Kawkawlin series ... 66
Loxley series ... 66
Lupton series ... 67
Mancelona series ... 67
Manistee series ... 68
Montcalm series ... 69
Nester series ... 69
Roscommon series ... 69
Rubicon series ... 70
Tawas series ... 70
Winterfield series ... 71

Issued August 1985

Index to Map Units

10A—Au Gres-Finch sands, 0 to 4 percent slopes 13
11A—Croswell sand, 0 to 4 percent slopes 14
12B—Emmet-Montcalm complex, 0 to 6 percent slopes 14
12C—Emmet-Montcalm complex, 6 to 12 percent slopes 15
12D—Emmet-Montcalm complex, 12 to 18 percent slopes 16
12E—Emmet-Montcalm complex, 18 to 40 percent slopes 16
13B—Grayling sand, 0 to 6 percent slopes 18
14A—Allendale loamy sand, 0 to 4 percent slopes 18
15B—Kalkaska sand, 0 to 6 percent slopes 18
15C—Kalkaska sand, 6 to 12 percent slopes 19
15E—Kalkaska sand, 12 to 40 percent slopes 20
16B—Hodenpyl-Karlin complex, 0 to 4 percent slopes 20
17A—Kawkawlin loam, 0 to 4 percent slopes 21
18—Loxley peat 21
19—Lupton muck 22
20B—Montcalm-Graycalm complex, 0 to 6 percent slopes 22
20C—Montcalm-Graycalm complex, 6 to 12 percent slopes 23
20E—Montcalm-Graycalm complex, 12 to 30 percent slopes 24
21B—Nester sandy loam, 1 to 6 percent slopes 24
21C—Nester sandy loam, 6 to 12 percent slopes 25
21E—Nester loam, 12 to 40 percent slopes 26
22—Tawas-Roscommon association 26
23B—Rubicon sand, 0 to 12 percent slopes 26
23E—Rubicon sand, 12 to 40 percent slopes 27
24D—Rubicon sand, 12 to 40 percent slopes, severely eroded 29
25—Pits 29
26B—Manistee-Montcalm loamy sands, 0 to 6 percent slopes 30
26C—Manistee-Montcalm loamy sands, 6 to 12 percent slopes 30
28C—Dighton loam, 6 to 12 percent slopes 31
29B—Graycalm-Grayling sands, 0 to 6 percent slopes 32
29D—Graycalm-Grayling sands, 6 to 30 percent slopes 32
30B—Kalkaska-East Lake sands, 0 to 6 percent slopes 33
30C—Kalkaska-East Lake sands, 6 to 12 percent slopes 33
30E—Kalkaska-East Lake sands, 12 to 30 percent slopes 34
34—Winterfield sand 34
35B—Mancelona-East Lake complex, 0 to 6 percent slopes 35
36B—Kalkaska sand, banded substratum, 0 to 6 percent slopes 35
36C—Kalkaska sand, banded substratum, 6 to 12 percent slopes 36
36E—Kalkaska sand, banded substratum, 12 to 40 percent slopes 36
37—Fluvaquents and Histosols 36

Summary of Tables

Temperature and precipitation (table 1) 88

Freeze dates in spring and fall (table 2) 89
Probability. Temperature.

Growing season (table 3) 90

Acreage and proportionate extent of the soils (table 4) 91
Lake County. Wexford County. Total—Area, Extent.

Yields per acre of crops and pasture (table 5) 92
Corn. Corn silage. Oats. Winter wheat. Grass-legume hay. Pasture.

Capability classes and subclasses (table 6) 94
Total acreage. Major management concerns.

Woodland management and productivity (table 7) 95
Ordination symbol. Management concerns. Potential productivity. Trees to plant.

Windbreaks and environmental plantings (table 8) 100

Recreational development (table 9) 104
Camp areas. Picnic areas. Playgrounds. Paths and trails. Golf fairways.

Wildlife habitat (table 10) 108
Potential for habitat elements. Potential as habitat for—Openland wildlife, Woodland wildlife, Wetland wildlife.

Building site development (table 11) 111
Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Local roads and streets. Lawns and landscaping.

Sanitary facilities (table 12) 115
Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.

Construction materials (table 13) 119
Roadfill. Sand. Gravel. Topsoil.

Water management (table 14) 123
Limitations for—Pond reservoir areas; Embankments, dikes, and levees; Aquifer-fed excavated ponds. Features affecting—Drainage, Irrigation, Grassed waterways.

Engineering index properties (table 15) 126
Depth. USDA texture. Classification—Unified AASHTO. Fragments greater than 3 inches. Percentage passing sieve—4, 10, 40, 200. Liquid limit. Plasticity index.

Physical and chemical properties of the soils (table 16) 130
Depth. Clay. Moist bulk density. Permeability. Available water capacity. Soil Reaction. Shrink-swell potential. Erosion factors. Wind erodibility group. Organic matter.

Soil and water features (table 17)... 133
Hydrologic group. Flooding. High water table. Potential frost action. Risk of corrosion.

Classification of the soils (table 18)... 135
Family or higher taxonomic class.

Foreword

This soil survey contains information that can be used in land-planning programs in Lake and Wexford Counties. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Homer R Hilner

Homer R. Hilner
State Conservationist
Soil Conservation Service

Soil Survey of
Lake and Wexford Counties Michigan

By Donald E. Buchanan, Soil Conservation Service

Fieldwork by Donald E. Buchanan, Joseph R. Dumont, and Richard L. Larson
Soil Conservation Service; David Cleland and Cheryl Reeder
Forest Service; and Patrict Sutton, Ronald Church, and Daniel Sandahl
Michigan Agricultural Experiment Station.

United States Department of Agriculture, Soil Conservation Service
in cooperation with
the Forest Service and
the Michigan Agricultural Experiment Station

General Nature of the Survey Area

Lake and Wexford Counties are in the west-central part of Michigan (fig. 1). They are bordered on the north by Grand Traverse County, on the east by Missaukee and Osceola Counties, on the south by Newaygo County, and on the west by Manistee and Mason Counties. The survey area is about 1,135 square miles, or 723,200 acres. Cadillac, the county seat of Wexford County, is the largest town in the survey area. It has a population of about 10,200. Baldwin, the county seat of Lake County, has a population of about 670.

Five rivers drain the area to Lake Michigan: The Manistee River in the north; the Pine, Little Manistee, and Clam Rivers in the central part; and the Pere Marquette River in the south. Drainage is generally east to west. The one exception is the Clam River, in southeastern Wexford County, which drains to the east and south into the Muskegon River. Thirty-four lakes are larger than 40 acres. The total area is about 9,200 acres. The largest is Lake Mitchell, near Cadillac, which is about 2,580 acres. Many small ponds are less than 40 acres in size, especially in western Lake County.

About 50 percent of Wexford County and about 35 percent of Lake County are made up of rolling to steep glacial moraines (fig. 2). Most of the remainder is undulating or nearly level glacial outwash plains. Lake and Wexford Counties are about 75 percent sandy soils,

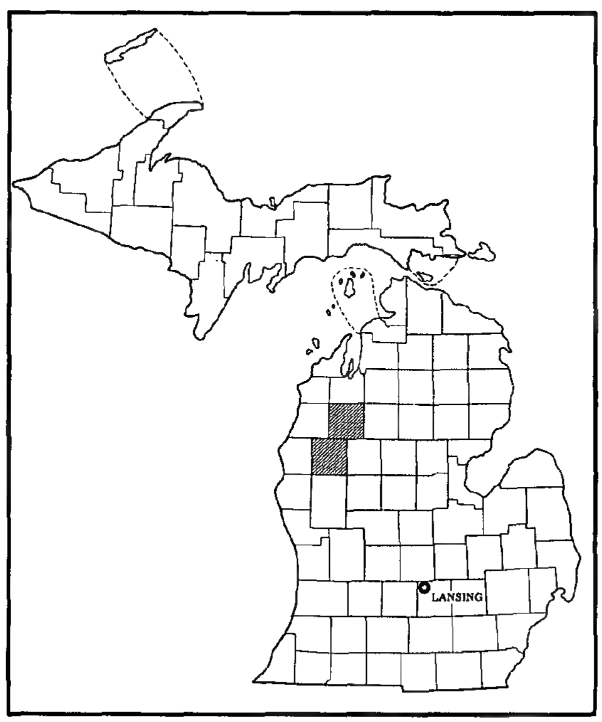


Figure 1.—Location of Lake and Wexford Counties, Michigan

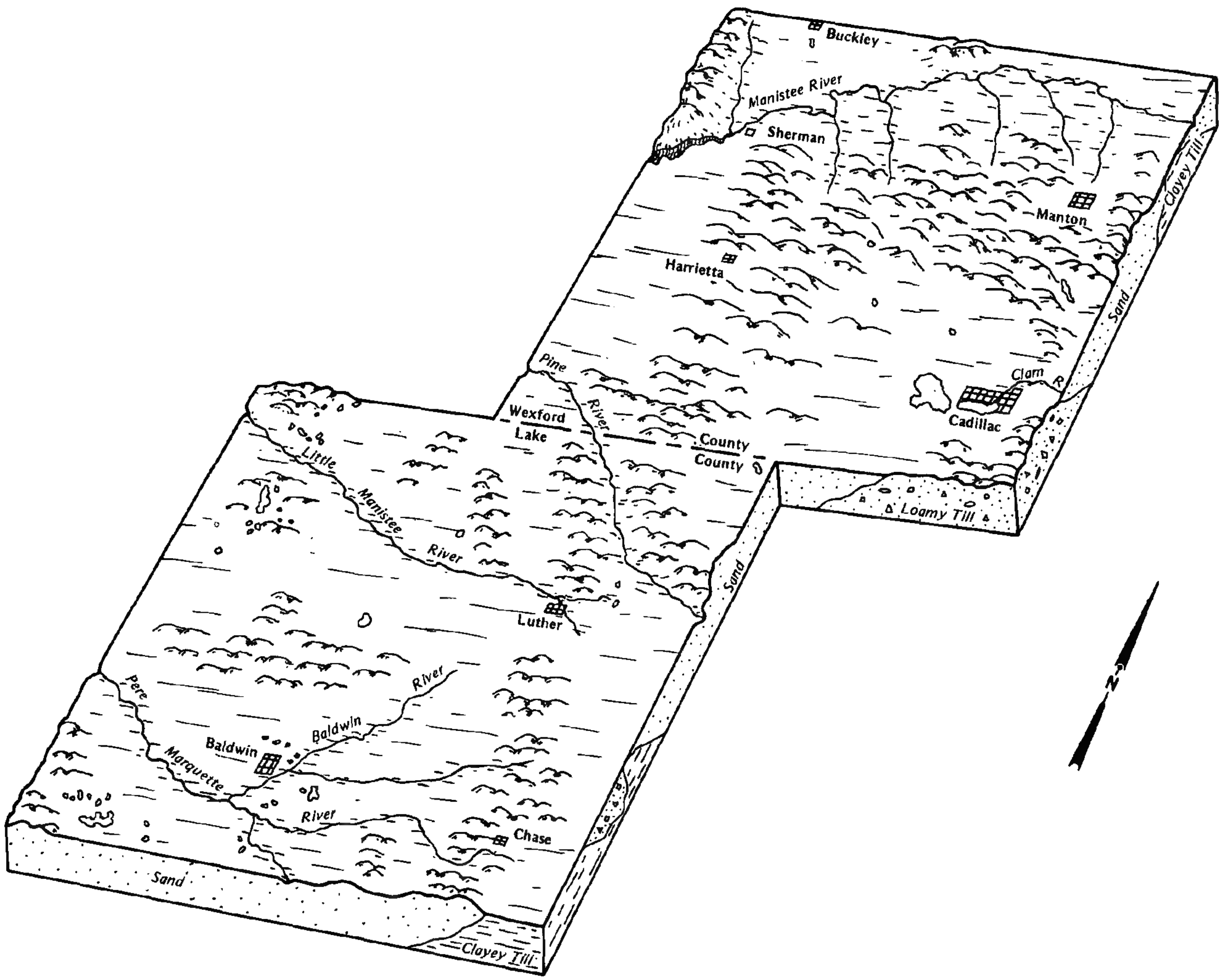


Figure 2.—Physiography of Lake and Wexford Counties, Michigan.

6 percent loamy soils, and 2 percent clayey soils in uplands. They are 15 percent wet sandy and mucky soils and 2 percent wet clayey soils. More than 70 percent is in woodland, and about 10 percent is in cultivated crops.

Climate of Lake County

Prepared by the Michigan Department of Agriculture, Climatology Division, East Lansing, Michigan.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Baldwin in the period 1951 to 1980. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 22.1 degrees F, and the average daily minimum temperature is 12.5 degrees. The lowest temperature on record, which occurred at Baldwin on Jaunary 19, 1951, is -37 degrees. In summer the average temperature is 67.0 degrees, and the average daily maximum temperature is 81.1 degrees. The highest recorded temperature, which occurred at Baldwin on June 27, 1949, is 104 degrees.

Growing degree days are shown in table 1. They are

equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 34.0 inches. Of this, 19.2 inches, or 56 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 15.9 inches. The heaviest 1-day rainfall during the period of record was 3.75 inches at Baldwin on July 28, 1969. Thunderstorms occur on about 35 days each year, and most occur in June in Grand Rapids. The wettest month was August 1975, with 12.80 inches of rainfall.

The average seasonal snowfall is 82.6 inches. The greatest snow depth at any one time during the period of record was 41 inches in January 1949 and 1969. The heaviest seasonal snowfall was 126.1 inches during the winter of 1981-82. The lowest seasonal snowfall was 21.4 inches during the winter of 1948-49. The heaviest 1-day snowfall on record was 33.5 inches on November 30, 1960. This is also the daily record for Michigan. The month of heaviest snowfall was January 1982, with 65.3 inches.

The average relative humidity in midafternoon is about 63 percent. Humidity is higher at night, and the average at dawn is about 82 percent. The sun shines 62 percent of the time possible in summer and 32 percent in winter. The prevailing wind is from the southwest. Average windspeed is highest, 11.5 miles per hour, in January in Grand Rapids.

Climate of Wexford County

Prepared by the Michigan Department of Agriculture, Climatology Division, East Lansing, Michigan.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Cadillac in the period 1951 to 1980. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 19.1 degrees F, and the average daily minimum temperature is 10.9 degrees. The lowest temperature on record, which occurred at Cadillac on January 30, 1951, is -43 degrees. In summer the average temperature is 64.4 degrees, and the average daily maximum temperature is 76.7 degrees. The highest recorded temperature, which occurred at Cadillac on July 13, 1936, is 104 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 30.81 inches. Of this, 18.38 inches, or 60 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 15.2 inches. The heaviest 1-day rainfall during the period of record was 3.77 inches at Cadillac on May 27 and 28, 1945. Thunderstorms occur on about 35 days each year, and most occur in July at Houghton Lake. The month of heaviest precipitation was August 1975, with 9.14 inches. The month of lowest precipitation was September 1979, with 0.06 inch.

Average seasonal snowfall is 71.2 inches. The greatest snow depth at any one time during the period of record was 42 inches on February 23 and 24, 1959. On an average of 115 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year. The heaviest seasonal snowfall was 140.2 inches during the winter of 1981-82. The lowest seasonal snowfall was 36.1 inches during the winter of 1957-58. The heaviest 1-day snowfall on record was 12.0 inches on March 26, 1930 and on January 27, 1978. The month of heaviest snowfall was January 1982, with 60.1 inches.

The average relative humidity in midafternoon is about 62 percent. (Data are from the National Weather Service at Houghton Lake.) Humidity is higher at night, and the average at dawn is about 84 percent. The prevailing wind is from the west-southwest. Average windspeed is highest, 10.0 miles per hour, in December.

History and Development

Lake and Wexford Counties were surveyed in 1836 and 1837. Originally, Lake County was named Aishcum, and Wexford County was named Kautawabet. The names were changed in 1843. Sherman became the county seat when Wexford County was formally organized in 1869. The county seat was moved from Sherman to Cadillac in 1882. Lake County was organized in 1871. Baldwin became the county seat.

Settlement began in 1863 when a new state road was constructed to connect Grand Rapids with Traverse City. In 1866 the construction of a sawmill near Sherman was the beginning of the lumbering industry. Lumbering continued to increase in importance with the extension into the area of the Grand Rapids and Indiana Railroad in 1871-72 and the Ann Arbor Railroad in 1887.

Many early settlers farmed during the summer and logged during the winter. As virgin forests were depleted, more and more people turned to farming as the principal means of livelihood. The acreage of farmland reached a peak about 1912, when 119,000 acres in Wexford County and 70,000 acres in Lake County were farmed. Many farms on the more droughty soils were later

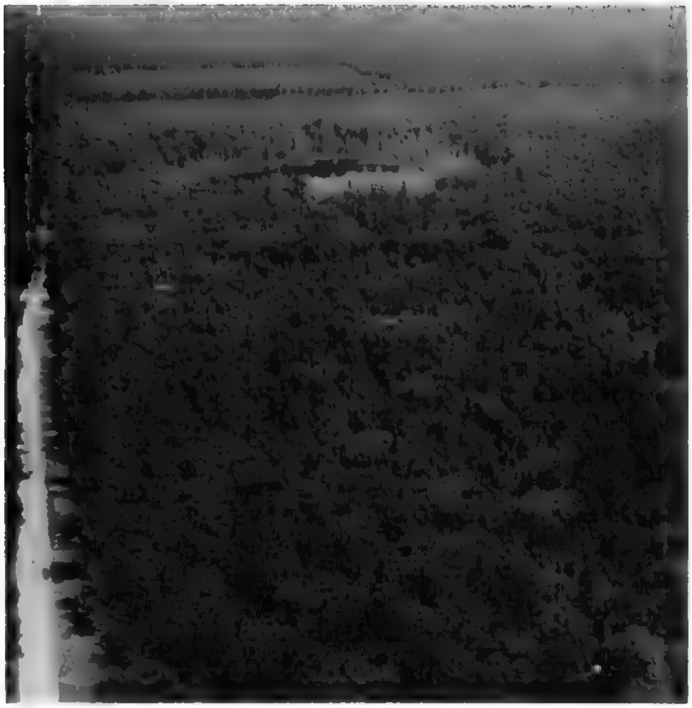


Figure 3.—More than 70 percent of Lake and Wexford Counties is woodland. Harvested areas are shown in the background. The soils are mostly in the Rubicon, Montcalm, and Graycalm series.

abandoned. Much of this acreage was replanted to pines. Timber harvesting and milling continued as an important industry, although on a diminishing scale. During the 1930's, the lumbering industry virtually ceased. At present, the more productive soils remain in cultivation. Logging operations are limited to pulpwood and a small amount of timber harvesting for lumber (fig. 3) (*7*).

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed, and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

This soil survey supersedes the soil survey of Wexford County published in 1909 (*3*). This survey updates the earlier survey and provides additional information. Maps are larger and show the soils in greater detail. Lake County has not been surveyed previously.

Some of the boundaries on the soil maps of Lake and Wexford Counties do not match those on the soil maps of adjacent counties, and some of the soil names and descriptions do not agree. The differences are a result of improvements in the classification of soils, particularly modifications or refinements in soil series concepts. Also, mapping of the soils may be different in intensity or in extent within the survey area.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Rubicon-Montcalm-Graycalm

Nearly level to steep, somewhat excessively drained and well drained sandy soils on moraines, till plains, and outwash plains

This map unit makes up 40 percent of the survey area. It is about 38 percent Rubicon soils, 28 percent Montcalm soils, 27 percent Graycalm soils, and 7 percent soils of minor extent.

The map unit is on nearly level and undulating plains and on rolling to steep ridges and hills.

In most places the Rubicon, Montcalm, and Graycalm soils are in positions on the landscape that are similar. In many areas they are adjacent on the same slope.

Rubicon soils are somewhat excessively drained. Typically, the surface layer is black sand about 2 inches thick. The subsurface layer is pinkish gray sand about 8 inches thick. The subsoil is very friable sand about 33 inches thick. The upper part is dark brown, the middle part is yellowish brown, and the lower part is brownish yellow. The underlying material to a depth of about 60 inches is very pale brown, loose sand.

Montcalm soils are well drained. Typically, the surface layer is very dark grayish brown loamy sand about 7 inches thick. The next layer to a depth of about 42 inches is brown and dark yellowish brown loamy sand. Below this is mixed brown, friable sandy loam and brown, very friable loamy sand to a depth of more than 60 inches.

Graycalm soils are somewhat excessively drained. Typically, the surface layer is black sand about 2 inches thick. The subsoil to a depth of about 28 inches is multicolored, loose sand. The next layer is light yellowish brown, loose sand about 20 inches thick. Between depths of 50 and 60 inches are alternate bands of light yellowish brown sand and strong brown loamy sand.

Soils of minor extent are the somewhat excessively drained Kalkaska soils; the well drained, less permeable Manistee soils; and the moderately well drained Croswell soils. Kalkaska and Manistee soils are on plains, ridges, and hills. Croswell soils are in drainageways and on low flats and benches.

Most of this map unit is woodland. Some areas are in hay and pasture or are idle. Many areas once cleared for farms have been planted to pine trees.

These soils are well suited to woodland. They are fairly well suited or poorly suited to hay and pasture. They are poorly suited to crops and most recreational uses. Droughtiness, sandiness, and slope are the major limitations. These soils are well suited to building site development on slopes of less than 15 percent. The Rubicon and Graycalm soils are limited by poor filtering capacity for use as septic tank absorption fields.

2. Grayling-Graycalm

Nearly level to moderately steep, excessively drained and somewhat excessively drained sandy soils on outwash plains, till plains, and low moraines

This map unit makes up 17 percent of the survey area. It is about 55 percent Grayling soils, 30 percent Graycalm soils, and 15 percent soils of minor extent (fig. 4).

The map unit is on nearly level plains and low, rolling hills and occasional short, steep slopes.

In most places the Grayling and Graycalm soils are in similar positions on the landscape and are adjacent on the same slope.

Grayling soils are excessively drained. Typically, the surface layer is black sand about 2 inches thick. The subsoil is dark yellowish brown and yellowish brown, loose sand about 24 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown sand.

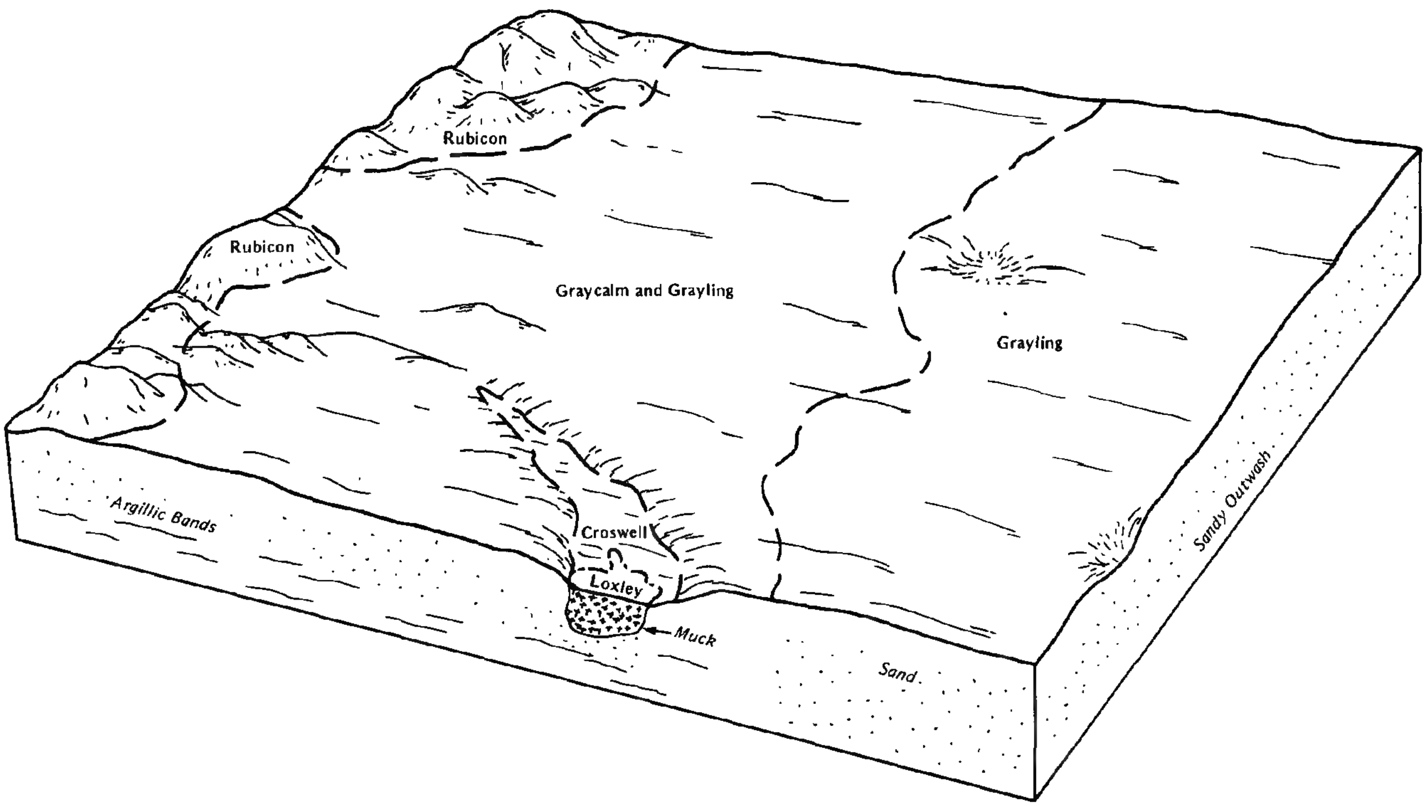


Figure 4.—Pattern of soils and underlying material in the Grayling-Graycalm map unit.

Graycalm soils are somewhat excessively drained. Typically, the surface layer is black sand about 2 inches thick. The subsoil to a depth of about 28 inches is multicolored, loose sand. The next layer is yellowish brown, loose sand about 20 inches thick. Between depths of 50 and 60 inches are alternate bands of light yellowish brown sand and strong brown loamy sand.

Soils of minor extent are the similar, moderately well drained Croswell soils; the very poorly drained Loxley soils; and the excessively drained Rubicon soils. Rubicon soils are mostly above the Grayling and Graycalm soils on the steeper hills. Croswell and Loxley soils are in swales and on low flats. They are near lakes and ponds.

Almost all of this map unit is woodland. Graycalm soils are well suited to woodland, and Grayling soils are poorly suited. These soils are poorly suited to most recreational uses. They are unsuitable for crops, hay, and pasture. Droughtiness and slope are the main limitations. These soils are fairly well suited as sites for buildings on slopes of less than 15 percent. They are limited by poor filtering capacity for use as septic tank absorption fields.

3. Kalkaska

Nearly level to steep, somewhat excessively drained and well drained sandy soils on outwash plains, till plains, and moraines

This map unit makes up 18 percent of the survey area It is about 88 percent Kalkaska soils and 12 percent soils of minor extent.

The Kalkaska soils are on nearly level and undulating plains and on rolling knolls to steep hills. They are somewhat excessively drained or well drained. Typically, the surface layer is black sand about 2 inches thick. The subsurface layer is brown sand about 10 inches thick. The subsoil is multicolored, very friable sand about 36 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, very friable sand.

Soils of minor extent are the excessively drained Rubicon soils and the well drained Montcalm soils. Montcalm and Rubicon soils are mostly in undulating and rolling parts of the landscape.

Most of this map unit is woodland. A few areas of the nearly level and undulating soils are in crops, hay, or pasture or are idle. These soils are well suited to

woodland. They are poorly suited to crops and to most recreational uses. The more gently sloping soils are fairly well suited to pasture. Droughtiness, sandiness, and slope are the main limitations. These soils are fairly well suited as sites for buildings on slopes of less than 15 percent. They are limited by poor filtering capacity for use as septic tank absorption fields.

4. Tawas-Croswell-Lupton

Nearly level and undulating, very poorly drained and moderately well drained mucky and sandy soils in bogs, depressions, and drainageways and on low flats and benches

This map unit makes up 16 percent of the survey area. It is about 26 percent Tawas soils, 22 percent Croswell soils, 8 percent Lupton soils, and 44 percent soils of minor extent (fig. 5).

In most places the Tawas and Lupton soils are in bogs, drainageways, and depressions. The Croswell soils are on the higher positions of flats and benches. All of these soils have a seasonal high water table.

The nearly level Tawas soils are very poorly drained. Typically, the surface layer is black muck about 29 inches thick. The subsoil is black and very dark gray, friable muck about 29 inches thick. The underlying material to a depth of about 60 inches is light brownish gray, loose sand.

The nearly level and gently undulating Croswell soils are moderately well drained. Typically, the surface layer is very dark gray sand about 2 inches thick. The subsurface layer is grayish brown sand about 13 inches thick. The subsoil is multicolored sand about 23 inches thick. The underlying material to a depth of about 60 inches is brown, mottled sand.

The nearly level Lupton soils are very poorly drained. Typically, the surface layer is very dark brown muck about 5 inches thick. The subsoil to a depth of about 60 inches is very dark grayish brown, friable muck.

Soils of minor extent are the very poorly drained, mineral Roscommon soils; the somewhat poorly drained Au Gres and Finch soils; the well drained Montcalm and Graycalm soils; and the excessively drained Rubicon

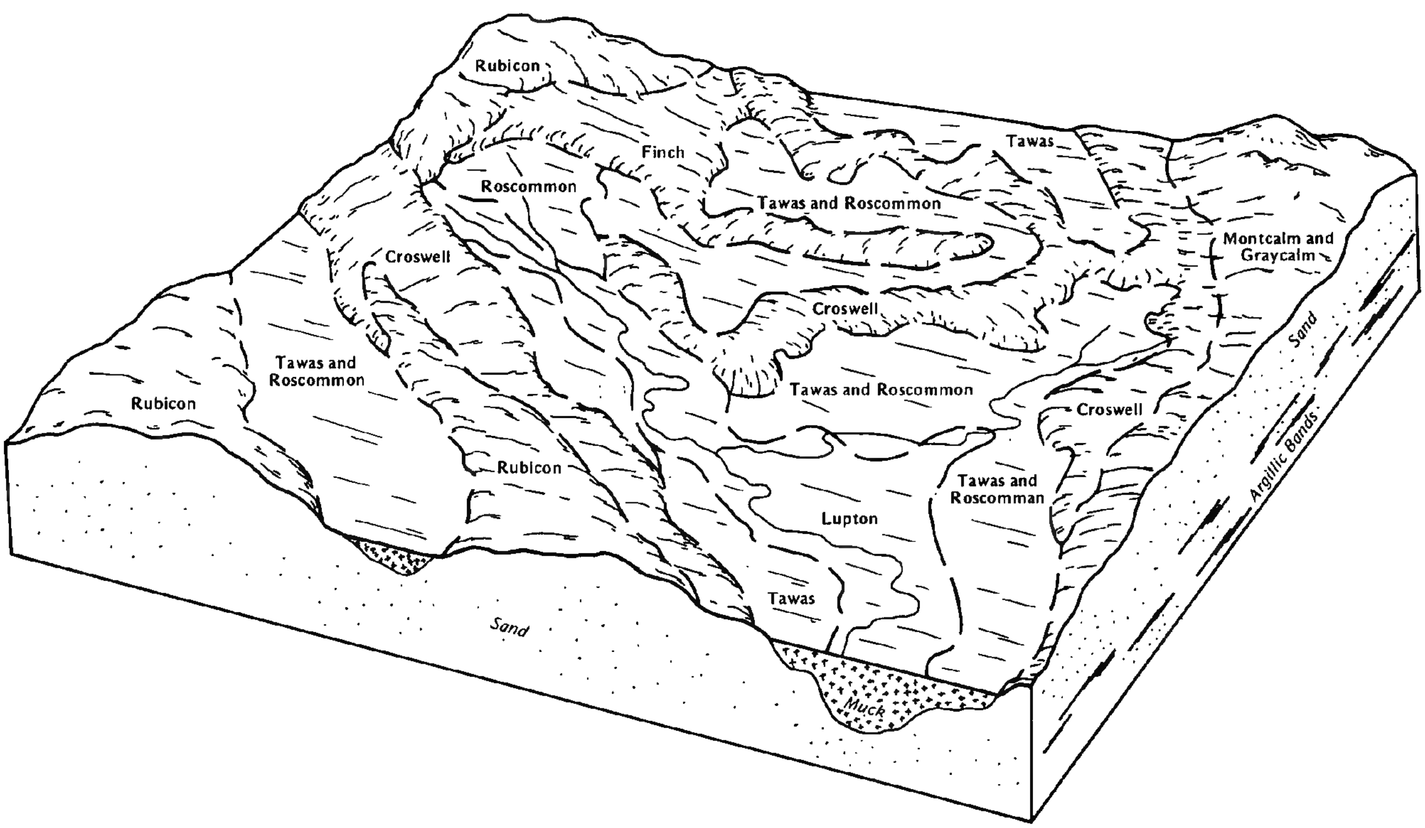


Figure 5.—Pattern of soils and underlying material in the Tawas-Croswell-Lupton map unit.

soils. The Roscommon soils are in bogs, drainageways, and depressions. Au Gres and Finch soils are on low flats and benches. Their positions in the landscape are slightly higher than the Tawas and Lupton soils and slightly lower than the Croswell soils. Rubicon, Montcalm, and Graycalm soils are in the highest positions on the landscape.

Almost all of this map unit is woodland. Tawas and Lupton soils are poorly suited to woodland. They are not suited to crops and pasture, most recreational uses, and building site development. Wetness and unstable soil material are severe limitations. Croswell soils are fairly well suited to woodland, hay and pasture, and recreational uses. They are poorly suited to crops. Droughtiness, sandiness, and seasonal wetness are the main limitations. Croswell soils are fairly well suited as sites for buildings without basements. Wetness and poor filtering capacity are limitations for use as septic tank absorption fields.

5. Emmet-Montcalm

Nearly level to steep, well drained loamy and sandy soils on till plains and moraines

This map unit makes up 5 percent of the survey area. It is about 35 percent Emmet soils, 30 percent Montcalm soils, and 35 percent soils of minor extent.

This map unit is on nearly level and undulating plains and on rolling knolls to steep hills. In most places Emmet and Montcalm soils are in positions on the landscape that are similar. Commonly, they are adjacent on the same slope.

Emmet soils are well drained. Typically, the surface layer is very dark grayish brown, very friable sandy loam about 8 inches thick. The next layer is brown, very friable sandy loam about 15 inches thick. Below this is mixed, reddish brown sandy loam and brown loamy sand about 5 inches thick. The subsoil is reddish brown, friable sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loamy sand.

Montcalm soils are well drained. Typically, the surface layer is very dark grayish brown loamy sand about 7 inches thick. The next layer to a depth of about 42 inches is brown and dark yellowish brown loamy sand. The next layer is mixed brown, friable sandy loam and brown, very friable loamy sand to a depth of more than 60 inches.

Soils of minor extent are the somewhat excessively drained Kalkaska soil; the well drained Manistee and Nester soils; and the very poorly drained Roscommon, Lupton, and Tawas soils. Kalkaska, Manistee, and Nester soils are on plains, knolls, and hills. The Lupton, Roscommon, and Tawas soils are in depressions, drainageways, and small bogs.

Most areas of this map unit are in crops, hay, or pasture. A few areas are woodland. Emmet soils are well suited to crops on slopes of less than 6 percent and are fairly well suited on slopes of less than 18 percent. Erosion control, soil blowing, and slope are the main limitations. Soils of this map unit are well suited to moderately well suited to hay and pasture, well suited to woodland, and fairly well suited to recreational uses. Slope is the main limitation. These soils are suited as sites for buildings on slopes of less than 15 percent and poorly suited on slopes of more than 15 percent.

6. Nester-Kawkawlin-Manistee

Nearly level to steep, well drained and somewhat poorly drained loamy and sandy soils on till plains and moraines

This association makes up 3 percent of the survey area. It is about 27 percent Nester soils, 22 percent Kawkawlin soils, 20 percent Manistee soils, and 31 percent soils of minor extent.

The Nester and Manistee soils are on nearly level and undulating plains and rolling knolls to steep hills. In most places they are in positions on the landscape that are similar. In many areas they are adjacent on the same slope. The Manistee soils, however, are less sloping. Kawkawlin soils are on low flats and in depressions.

Nester soils are well drained. Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsurface layer is brown loam about 3 inches thick. The next layer is mixed, brown sandy loam and reddish brown clay loam about 7 inches thick. The subsoil is very firm, dark reddish brown clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is calcareous, reddish brown sandy clay loam and brown clay loam.

Kawkawlin soils are somewhat poorly drained. Typically, the surface layer is dark gray loam about 7 inches thick. The next layer is grayish brown and brown, mottled, firm clay loam and silt loam about 5 inches thick. The subsoil is brown, mottled, very firm silty clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is calcareous, dark grayish brown, firm silty clay loam.

Manistee soils are well drained. Typically, the surface layer is very dark gray loamy sand and brown loamy sand about 4 inches thick. The upper part of the subsoil is very friable, reddish brown loamy sand and strong brown sand about 14 inches thick. The next layer is mixed brown loamy sand and reddish brown sandy clay loam about 23 inches thick. The lower part of the subsoil is brown, very firm clay about 6 inches thick. The underlying material to a depth of about 60 inches is calcareous, brown, firm clay.

Soils of minor extent are the somewhat poorly drained Allendale soils that have a sandy surface layer; the well drained, more droughty Emmet, Graycalm, and Montcalm soils; and the somewhat excessively drained Kalkaska

soils. The Allendale soils are on low flats and in depressions. Emmet or Montcalm soils are on plains, knolls, and hills. The Kalkaska soils are commonly on the top of knolls and ridges.

Most areas of this map unit are in hay and pasture or are idle. Some areas are in crops; others are woodland. Nester soils are well suited to hay or pasture and fairly well suited to crops. They are well suited to woodland and to recreational uses. They are poorly suited as sites for buildings. Erosion control, maintaining organic matter, tilth, slope, and slow permeability are major concerns. Kawkawlin soils are well suited to hay or pasture. They are fairly well suited to crops or woodland. They are poorly suited to recreational uses and as building sites. Wetness, poor tilth, and permeability are major limitations. Manistee soils are well suited to hay, pasture, or woodland. They are moderately well suited to crops or to recreational uses. Sandiness, soil blowing, and slope are the main limitations. Manistee soils are well suited as sites for buildings. They have severe limitations for use as septic tank absorption fields because of permeability in the lower part of the profile.

7. Hodenpyl-Karlin

Nearly level and undulating, well drained and somewhat excessively drained loamy and sandy soils on outwash plains

This map unit makes up only 1 percent of the survey area. It is about 46 percent Hodenpyl soils, 46 percent Karlin soils, and 8 percent soils of minor extent.

The map unit is on nearly level and gently undulating plains. The Hodenpyl and Karlin soils are in positions on the landscape that are similar. They are adjacent on the same slopes (fig. 6).

Figure 6.—The soils in the Hodenpyl-Karlin map unit are prime farmland. Strips of alfalfa-bromegrass alternating with corn or snap beans help protect the soil from blowing.

Hodenpyl soils are well drained. Typically, the surface layer is very dark grayish brown sandy loam about 10 inches thick. The subsurface layer is dark brown fine sandy loam about 3 inches thick. The subsoil is brown and dark brown, friable sandy loam about 28 inches thick. The next layer to a depth of 60 inches is alternating bands of pale brown sand and strong brown loamy sand.

Karlin soils are somewhat excessively drained. Typically, the surface layer is dark grayish brown loamy fine sand about 9 inches thick. The very friable subsoil is about 20 inches thick. The upper part is dark brown and brown loamy fine sand, and the lower part is brown loamy sand. The underlying material to a depth of 60 inches is yellowish brown sand.

Some soils of minor extent are similar to one or more of the major soils. They are the somewhat excessively drained East Lake and Kalkaska soils. These soils are on plains, but they are commonly near the margins of areas.

Most areas of this map unit are in crops. Scattered small areas are in pasture or are woodland. The major concern is susceptibility to soil blowing. These soils are well suited to most land uses. They have poor filtering capacity for use as septic tank absorption fields.

Broad Land Use Considerations

The soils of Lake and Wexford Counties vary widely in their suitability for major land uses. The general soil map in the back of this report can be very helpful in locating broad areas that are generally suited to planning future land uses. This map should not be used for making land use decisions for a specific tract of land.

Woodland is the most common land use. About 73 percent of the survey area is wooded. Most soils are generally suited to woodland. The soils in the Kalkaska, Emmet-Montcalm, Nester-Kawkawlin-Manistee, and Hodenpyl-Karlin general soil map units support good stands of northern hardwoods. They also are well suited to pines. These soils make up about 27 percent of the survey area. The soils of Rubicon-Montcalm-Graycalm map unit support good stands of oak and pines. They make up about 40 percent of the survey area. These soils have good suitability for continuous commercial timber. The soils of the Grayling-Graycalm map unit have only fair or poor suitability for pines because of droughtiness. The soils of Tawas-Croswell-Lupton map unit support fair stands of wetland hardwoods and conifers, but they have poor suitability for continuous use as commercial timber.

About 55 percent of the soils of the survey area have good or fair suitability for residential development. These soils are not wet, and slopes are less than 15 percent. They are in the Rubicon-Montcalm-Graycalm, Grayling-Graycalm, Kalkaska, Emmet-Montcalm, Nester-Kawkawlin-Manistee, and Hodenpyl-Karlin map units. Many of these soils have limitations for septic tank absorption fields. The sandy soils in the Rubicon-Montcalm-Graycalm, Grayling-Graycalm, Kalkaska, and Emmet-Montcalm map units have poor filtering capacity. The soils that have a clayey subsoil in the Nester-Kawkawlin-Manistee map unit have slow permeability. The steep soils and wet soils have poor suitability for residential development.

Only about 8 percent of the soils in Lake and Wexford Counties have good or fair suitability for crops. These are the well drained soils that have slopes of less than 12 percent in the Emmet-Montcalm, Nester-Kawkawlin-Manistee, and Hodenpyl-Karlin map units. About 35 percent of the soils of the survey area have good or fair suitability for permanent pasture.

The suitability for recreation and habitat for openland wildlife is good or fair in about 70 percent of the area.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Kalkaska sand, banded substratum, 6 to 12 percent slopes, is one of several phases in the Kalkaska series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Emmet-Montcalm complex is an example.

A *soil association* is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Tawas-Roscommon association is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Fluvaquents and Histosols is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

10A—Au Gres-Finch sands, 0 to 4 percent slopes. This map unit consists of nearly level and undulating, somewhat poorly drained soils. Areas of these soils are intermingled on low flats and benches. This map unit is adjacent to drainageways and bogs. It is irregular in shape and ranges from about 5 to 200 acres. The Au Gres soil makes up 50 to 55 percent of the unit, and the Finch soil makes up about 35 to 40 percent. Areas of these soils are so small in size that mapping them separately is not practical.

Typically, the Au Gres soil has a surface layer of very dark gray sand about 2 inches thick. The subsurface layer is light brownish gray sand about 9 inches thick. The subsoil is multicolored, very friable or loose sand about 27 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, loose sand.

Typically, the Finch soil has a surface layer of very dark gray sand about 4 inches thick. The subsurface layer is brown sand about 8 inches thick. The mottled subsoil is about 23 inches thick. The upper part is dark reddish brown and strong brown, very friable sand; the middle part is reddish brown and yellowish red, strongly cemented sand; the lower part is brown, loose sand. The underlying material to a depth of about 60 inches is yellowish brown and light yellowish brown, mottled, loose sand.

Included with these soils in mapping are small areas of very poorly drained Roscommon soils and moderately well drained Croswell soils. The Roscommon soils are in drainageways and depressions. Croswell soils are on low mounds and ridges. Also included are small areas of less permeable Allendale soils that are on low flats and benches in positions similar to those of the Au Gres or Finch soils. These included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Au Gres soil. It is slow in the cemented layer of the Finch soil and rapid in the rest. Surface runoff is slow in the Au Gres and Finch soils and available water capacity is low. The seasonal high water table is at a depth of 1/2 foot to 1 1/2 feet from November to June.

Most of these soils are in woodland. A few areas are used for pasture.

These soils are well suited to woodland. Common native trees are red maple, paper birch, white spruce, balsam fir, and eastern hemlock. Use of equipment is limited by sand. The sandy surface limits trafficability of equipment. Windthrow is a hazard in some areas because a cemented layer in the subsoil restricts root growth. Harvesting methods should not leave wide spaces between trees.

These soils are poorly suited to crops. Crops are generally not grown. These soils frequently are in low areas that have short frost-free growing seasons. Crops can be affected by frost late in the spring and early in the fall.

These soils are fairly well suited to hay and pasture. Proper stocking and deferment of grazing during wet periods help keep the pasture in good condition. These soils are poorly suited as sites for buildings and septic tank absorption fields. The major management concern is the seasonal high water table. Buildings can be placed on raised, well compacted fill. Artificial drainage using surface or subsurface methods helps lower the water table if the soil is used for building site development. Special construction, such as filling or mounding with suitable soil material, may be needed to raise the absorption field site above the water table.

The land capability classification is IVw. The Michigan soil management groups are 5b and 5b-h.

11A—Croswell sand, 0 to 4 percent slopes. This nearly level and undulating, moderately well drained soil is on low flats and benches and is adjacent to drainageways and bogs. Individual areas are irregular in shape and range from about 5 to 300 acres.

Typically, the surface layer is very dark gray sand about 2 inches thick. The subsurface layer is grayish brown sand about 13 inches thick. The subsoil is multicolored sand about 23 inches thick. The underlying material to a depth of about 60 inches is brown, mottled sand.

Included with this soil in mapping are small areas of somewhat poorly drained Allendale and Au Gres soils in swales and depressions. These soils make up 5 to 10 percent of the unit.

Permeability is rapid in this Croswell soil, and available water capacity is low. The seasonal high water table is at a depth of 2 to 3 feet from November to April.

Most areas of this soil are woodland. Some small areas are in pasture.

This soil is well suited to woodland. Common native trees are red maple, paper birch, white spruce, balsam fir, quaking aspen, northern red oak, bigtooth aspen, red pine, and eastern white pine. Seedling mortality is caused by droughtiness. Seedling survival can be increased by using high quality stock when replanting trees. The sandy surface limits trafficability of equipment during dry periods.

This soil is poorly suited to crops because of droughtiness and soil blowing, but such crops as winter wheat and oats can be grown.

This soil is poorly suited to hay and pasture. Droughtiness is a problem. Proper stocking, pasture rotation, and deferment of grazing during dry periods help keep the pasture and the soil in good condition.

This soil is poorly suited as sites for buildings because of wetness. It is poorly suited as sites for septic tank absorption fields because of wetness and poor filtering capacity. Artificial drainage using surface or subsurface methods helps lower the water table if the soil is used for buildings. Special construction, such as filling or mounding with suitable soil material, may be needed to raise the absorption field site above the water table and to increase the filtering capacity for sewage disposal.

The land capability classification is IVs. The Michigan soil management group is 5a.

12B—Emmet-Montcalm complex, 0 to 6 percent slopes. This map unit consists of nearly level and undulating, well drained soils. Areas of Emmet and Montcalm soils are intermingled on plains and knolls. The map unit is irregular in shape and ranges from about 5 to 120 acres. The Emmet soil makes up about 60 to 65 percent of the unit, and the Montcalm soil makes up about 20 to 25 percent of the unit. These soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Emmet soil is very dark grayish brown, very friable sandy loam about 8

inches thick. The next layer is brown, very friable sandy loam about 15 inches thick. Below this is mixed, reddish brown sandy loam and brown loamy sand about 5 inches thick. The subsoil is reddish brown, friable sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loamy sand.

Typically, the surface layer of the Montcalm soil is very dark grayish brown loamy sand about 7 inches thick. The next layer to a depth of about 42 inches is brown and dark yellowish brown loamy sand. Below this to a depth of more than 60 inches is mixed brown, friable sandy loam and brown, very friable loamy sand.

Included with these soils in mapping are small areas of somewhat poorly drained Allendale soils, somewhat excessively drained Kalkaska soils, and well drained Nester soils. The Allendale and Nester soils are less permeable than the Emmet and Montcalm soils, and the Kalkaska soils are more droughty. The Allendale soils are on low flats and in depressions. The Kalkaska and Nester soils are on plains and knolls. These included soils make up 10 to 15 percent of the unit.

Permeability is moderate in the Emmet soil and moderately rapid in the Montcalm soil. Available water capacity is moderate, and surface runoff is slow. The surface layer is friable and easily tilled.

Most areas of these soils are in crops. Some areas are woodland or in pasture. The wooded areas are mostly small farm woodlots.

These soils are well suited to woodland. They support native stands of sugar maple, quaking aspen, American beech, yellow birch, and American basswood. Seedling mortality is a management concern. In some areas planting containerized seedlings, good site preparation, and replanting seedlings help to reduce seedling mortality.

These soils are well suited to such crops as corn, small grains, and alfalfa-bromegrass for hay. They are among the most productive soils in the survey area. The main concerns of management are soil erosion, soil blowing, conserving soil moisture, and inceasing organic matter content. A crop rotation system that includes grass and legumes helps to increase organic matter and control soil erosion. Alternate strips of hay and row crops are commonly used to control erosion. Organic matter in the soil can be increased by the addition of barnyard manure or green manure crops. Conservation tillage, which does not invert the soil and leaves all or part of the crop residue on the surface, conserves soil and leaves all or part of the crop residue on the surface, conserves soil moisture, and controls soil blowing.

These soils are well suited to pasture. Proper stocking and deferment of grazing during dry periods prevent overgrazing and keep the pasture and soil in good condition.

These soils are well suited as sites for buildings and septic tank absorption fields. There are no major concerns.

The land capability classification is IIe. The Michigan soil management groups are 3a and 4a.

12C—Emmet-Montcalm complex, 6 to 12 percent slopes. This map unit consists of gently rolling, well drained soils. Areas of Emmet and Montcalm soils are intermingled on ridges and knolls. The map unit is irregular in shape and ranges from about 5 to 400 acres. The Emmet soil makes up about 45 to 55 percent of the unit, and the Montcalm soil makes up about 35 to 45 percent of the unit. Areas of these soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Emmet soil is very dark grayish brown, very friable sandy loam about 8 inches thick. The next layer is brown, very friable sandy loam about 13 inches thick. Below this is mixed reddish brown sandy loam and brown loamy sand about 5 inches thick. The subsoil is reddish brown, friable sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, calcareous loamy sand.

Typically, the surface layer of the Montcalm soil is very dark grayish brown loamy sand about 7 inches thick. The next layer to a depth of about 42 inches is brown and dark yellowish brown loamy sand. Below this is mixed brown, friable sandy loam and brown, very friable loamy sand to a depth of more than 60 inches.

Included with these soils in mapping are small areas of somewhat excessively drained Kalkaska soils and well drained Nester soils. The Kalkaska soils are more droughty than the Emmet or Montcalm soils, and the Nester soils are less permeable. The Kalkaska and Nester soils are on ridges and knolls. These inclusions make up 8 to 12 percent of the unit.

Permeability is moderate in the Emmet soil and moderately rapid in the Montcalm soil. Available water capacity is moderate, and surface runoff is slow to medium. The surface layer is friable and easily tilled.

Most areas of these soils are in crops or pasture. Some areas are woodland. The wooded areas are mostly small farm woodlots. A few wooded areas are pine plantations.

These soils are well suited to woodland. They support native stands of sugar maple, American beech, yellow birch, and American basswood. Seedling mortality is a management concern in some areas. Planting containerized seedlings in well prepared sites and replanting seedlings can help to reduce seedling mortality.

These soils are fairly well suited to crops. Corn, small grains, and alfalfa-bromegrass for hay can be grown. The major management concerns are controlling water erosion and soil blowing, conserving soil moisture, and

maintaining soil fertility and content of organic matter. A crop rotation system that includes grasses and legumes helps increase organic matter content and control erosion. Alternate strips of hay and row crops on the contour are commonly used to control erosion. Organic matter can be increased in the soil by the addition of barnyard manure or green manure crops. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface conserves soil moisture and controls erosion and soil blowing.

These soils are well suited to pasture. Proper stocking and deferment of grazing during excessively dry periods help keep the pasture in good condition.

These soils are fairly well suited as sites for buildings and septic tank absorption fields. Slope is a limitation. Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas to construct buildings and to install septic tanks. Installing the distribution lines of the septic tank absorption fields across the slope is generally necessary for proper operation.

The land capability classification is IIIe. The Michigan soil management groups are 3a and 4a.

12D—Emmet-Montcalm complex, 12 to 18 percent slopes. This map unit consists of rolling, well drained soils. Areas of Emmet and Montcalm soils are intermingled on high knolls. The map unit is irregular in shape and ranges from about 5 to 1,000 acres or more. The Emmet soil makes up about 50 to 55 percent of the unit, and the Montcalm soil makes up about 45 to 50 percent of the unit. Areas of these soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Emmet soil is very dark grayish brown, very friable sandy loam about 8 inches thick. The next layer is brown, very friable sandy loam about 12 inches thick. Below this is mixed reddish brown sandy loam and brown loamy sand about 5 inches thick. The subsoil is yellowish brown, friable sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, very friable, calcareous loamy sand.

Typically, the surface layer of the Montcalm soil is very dark grayish brown loamy sand about 7 inches thick. The next layer to a depth of about 42 inches is brown and dark yellowish brown loamy sand. Below this is mixed brown, friable sandy loam and brown loamy sand to a depth of more than 60 inches.

Included with these soils in mapping are small areas of the somewhat excessively drained East Lake and Kalkaska soils and the well drained Nester soils. East Lake and Kalkaska soils are more droughty than Emmet and Montcalm soils, and Nester soils are less permeable. These included soils are on high knolls. They make up 5 to 10 percent of the unit.

Permeability is moderate in the Emmet soil and moderately rapid in the Montcalm soil. Available water capacity is moderate, and surface runoff is medium to rapid.

Many areas of these soils are used for crops. Other areas are in hay or pasture or are idle. Some areas of these soils are woodland. These wooded areas are mostly small farm woodlots that support stands of native hardwoods. A few areas are in pine plantations.

These soils are well suited to woodland. Common native trees are sugar maple, American beech, yellow birch, and American basswood. Seedling mortality is a management concern in some areas. The use of containerized seedlings, good site preparation, and replanting can help to reduce seedling mortality.

These soils are poorly suited to crops but are fairly well suited to hay and pasture. Corn, small grains, and alfalfa-bromegrass can be grown. Controlling water erosion on these soils is a major concern. Other concerns of management are controlling soil blowing, conserving soil moisture, and increasing content of organic matter. A crop rotation system that includes grasses and legumes helps maintain organic matter and control erosion. Alternate strips of hay and row crops planted on the contour are commonly used to control erosion (fig. 7). Organic matter can be increased in the soil by the addition of barnyard manure or green manure crops. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface conserves soil moisture and helps control erosion and soil blowing. Where areas are used for pasture, proper stocking and timely deferment of grazing during excessively dry periods keep the pasture in good condition.

These soils are poorly suited as sites for buildings and septic tank absorption fields. Slope is a major concern. Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. In some places septic tank absorption fields can be installed on the contour.

The land capability classification is IVe. The Michigan soil management groups are 3a and 4a.

12E—Emmet-Montcalm complex, 18 to 40 percent slopes. This map unit consists of moderately steep and steep, well drained soils. Areas of Emmet and Montcalm soils are intermingled on hills and ridges. The map unit is irregular in shape and ranges from about 5 to 300 acres. The Emmet soil makes up 45 to 55 percent of the unit, and the Montcalm soil makes up 35 to 45 percent of the unit. Areas of these soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Emmet soil is very dark grayish brown loamy sand about 6 inches thick. The next layer is dark brown and brown, very friable loamy

Figure 7.—Strips of alfalfa-bromegrass hay alternating with corn on Emmet-Montcalm complex. If well managed, these soils can be cropped on 0 to 18 percent slopes without serious erosion.

sand about 13 inches thick. Below this is mixed reddish brown sandy loam and brown loamy sand about 4 inches thick. The subsoil is brown, very friable loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loamy sand.

Typically, the surface layer of the Montcalm soil is very dark grayish brown loamy sand about 7 inches thick. The next layer to a depth of about 42 inches is brown and dark yellowish brown loamy sand. Below this is mixed brown, friable sandy loam and brown, very friable loamy sand to a depth of more than 60 inches.

Included with these soils in mapping are small areas of the somewhat excessively drained East Lake and Kalkaska soils. East Lake and Kalkaska soils are more droughty than Emmet and Montcalm soils. They are on hills and ridges and make up 5 to 10 percent of the unit.

Permeability is moderate in the Emmet soil and moderately rapid in the Montcalm soil. Surface runoff is moderate or rapid.

Most of these soils are in pasture or are idle. Some areas are woodland. These wooded areas are mostly small farm woodlots. A few areas are in pine plantations.

These soils are well suited to woodland. They support native stands of sugar maple, American beech, and American basswood. Management concerns are the hazard of erosion, equipment limitation, and in some areas, seedling mortality. Roads, skid trails, and landings should be located on gentle grades. Removing water with water bars, culverts, and drop structures helps control erosion. Planting containerized seedlings, good site preparation, and replanting seedlings may be needed in some areas to reduce seedling mortality.

These soils are not suited to crops or pasture because of steep slopes.

These soils are poorly suited as sites for buildings and septic tank absorption fields. Slope is a severe limitation that is difficult to overcome.

The land capability classification is VIe. The Michigan soil management groups are 3a and 4a.

13B—Grayling sand, 0 to 6 percent slopes. This nearly level and undulating, excessively drained soil is on broad outwash plains. Individual areas range from about 300 acres to several square miles.

Typically, the surface layer is black sand about 2 inches thick. The subsoil is dark yellowish brown and yellowish brown, loose sand about 24 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown sand.

Included with this soil in mapping are small areas of moderately well drained Croswell soils. The Croswell soils are in swales and on flats and are adjacent to lakes and ponds. These soils make up 2 to 5 percent of the unit.

Permeability is rapid, surface runoff is slow, and available water capacity is low.

Most areas of this soil are woodland. The soil is poorly suited to woodland and supports only scrubby stands of oak and jack pine. The major management concerns are equipment limitations and seedling mortality. The sandy surface can limit the trafficability of equipment during dry periods. Seedling mortality is caused by droughtiness. Trees grow very slowly. Seedling mortality is high, and new stands are difficult to establish. The loss of planted or natural tree seedlings in dry years can exceed 50 percent.

This soil is not suitable for crops or pasture because of droughtiness and soil blowing.

This soil is well suited as sites for buildings. It is fairly well suited to septic tank absorption fields. Poor filtering capacity is a limitation. The soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water supplies.

The land capability classification is VIs. The Michigan soil management group is 5.7a.

14A—Allendale loamy sand, 0 to 4 percent slopes. This nearly level and undulating, somewhat poorly drained soil is on low flats and in drainageways. Individual areas are irregular in shape and range from about 5 to 100 acres.

Typically, the surface layer is black loamy sand about 4 inches thick. The next layer is brown, very friable loamy sand about 23 inches thick. The next layer, about 10 inches thick, is mixed reddish brown clay loam and brown loam mottled with yellowish brown. The lower part of the subsoil is reddish brown, mottled, very firm clay. The underlying material to a depth of about 60 inches is reddish brown, mottled, very firm clay that is calcareous.

Included with this soil in mapping are small areas of somewhat poorly drained Au Gres and Finch soils. Au Gres and Finch soils do not have loamy and clayey materials in the lower part of the profile. They are on low flats and in drainageways. The included soils make up 10 to 15 percent of the unit.

Permeability in this Allendale soil is rapid in the upper part of the profile and slow in the lower part. Surface runoff is slow, and available water capacity is moderate. The seasonal high water table is at a depth of 1/2 foot to 1 1/2 feet from November to May. The surface layer is friable and easily tilled.

Most areas of this soil are in pasture or are idle. Some areas are in crops or are woodland.

The soil is fairly well suited to woodland. Common native trees are red maple, quaking aspen, paper birch, white spruce, balsam fir, and eastern white pine. The use of equipment is limited by wetness. This limitation can be avoided by using equipment when the ground is dry or frozen.

This soil is fairly well suited to such crops as corn and small grains. The major management concern is wetness. Subsurface drains and open ditches can lower the seasonal high water table. In many areas drainage outlets are difficult to locate.

This soil is well suited to hay and pasture. Proper stocking, pasture rotation, and deferment of grazing during dry periods help keep the pasture and soil in good condition.

This soil is poorly suited as sites for buildings because of wetness. It is limited for septic tank absorption fields by wetness, slow permeability in the underlying material, and poor filtering capacity in the upper part. Surface or subsurface drainage systems help lower the water table if this soil is used as sites for buildings. Buildings can be placed on raised, well compacted fill material. Special construction, such as filling or mounding with suitable soil material, may be needed to raise the absorption field site above the water table and increase filtering capacity for sewage disposal.

The land capability classification is IIIw. The Michigan soil management group is 4/1b.

15B—Kalkaska sand, 0 to 6 percent slopes. This nearly level and undulating, somewhat excessively drained soil is on plains and knolls. Individual areas are irregular in shape and range from about 10 to 1,000 acres.

Typically, the surface layer is black sand about 2 inches thick. The subsurface layer is brown sand about 10 inches thick. The subsoil is multicolored, very friable sand about 36 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, very friable sand. In places the dark reddish brown layer in the upper part of the subsoil is very thin or absent.

Permeability is rapid, available water capacity is low, and surface runoff is slow.

Most areas of this soil are woodland. Only a few areas are farmed. A few areas are in pasture.

This soil is well suited to woodland (fig. 8). Common native trees are sugar maple, American beech, northern red oak, eastern white pine, and red pine. Seedling mortality caused by droughtiness and equipment limitations are the main management concerns. Planting containerized seedlings in well prepared sites can reduce seedling mortality. The sandy surface can limit trafficability of equipment during dry periods.

This soil is poorly suited to crops. Conserving soil moisture, increasing the content of organic matter, and controlling soil blowing are the main management concerns. Corn, potatoes, and small grains can be grown (fig. 9). Crops generally do well only in years of above normal rainfall. Organic matter can be increased in the soil by the addition of barnyard manure or green manure crops. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface helps conserve soil moisture and control soil blowing.

Figure 8.—A typical stand of northern hardwoods on Kalkaska sand. If well managed, this soil can produce continuous high yields of hardwood timber.

This soil is fairly well suited to pasture. The major management concern is droughtiness. Pastures dry up during the summer months and become susceptible to soil blowing if they are overgrazed. Proper stocking, rotation of pastures, and deferment of grazing during dry periods help keep the pasture and the soil in good condition.

This soil is well suited as sites for buildings. It is fairly well suited as sites for septic tank absorption fields. Poor filtering capacity is a limitation for septic tank absorption fields. The soil readily absorbs the effluent from septic tank absorption fields but does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IVs. The Michigan soil management group is 5a.

15C—Kalkaska sand, 6 to 12 percent slopes. This gently rolling, somewhat excessively drained soil is on ridges and knolls. Individual areas are irregular in shape and range from about 10 to 200 acres.

Typically, the surface layer is black sand about 2 inches thick. The subsurface layer is brown sand about 10 inches thick. The subsoil is multicolored, very friable sand about 36 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, very friable sand. In places the dark reddish brown layer in the upper part of the subsoil is very thin or absent.

Permeability is rapid, available water capacity is low, and surface runoff is slow.

A few areas of this soil are in pasture. Most areas are woodland.

This soil is well suited to woodland. Common native trees are sugar maple, American beech, northern red oak, eastern white pine, and red pine. The major management concerns are seedling mortality caused by droughtiness and equipment limitations. Planting containerized seedlings in well prepared sites can reduce seedling mortality. The sandy surface can limit trafficability of equipment during dry periods.

This soil is not suitable for crops because of droughtiness and slope. Crops are generally not grown.

This soil is poorly suited to pasture. The major management concern is droughtiness. Pastures dry up during the summer months and become susceptible to soil blowing if they are overgrazed. Proper stocking rates, rotation of pastures, and deferment of grazing during dry periods help keep the pasture and soil in good condition.

This soil is fairly well suited as sites for buildings but is poorly suited as sites for septic tank absorption fields. Slope is the major limitation. Poor filtering capacity is an additional limitation for septic tank absorption fields. Buildings constructed on this soil should be designed to

Figure 9.—Potatoes grow well in Kalkaska sand, 0 to 6 percent slopes, if it is irrigated.

conform to the natural slope of the land. Land shaping may be necessary in some areas. Installing the distribution lines across the slope is generally necessary for the proper operation of septic tank absorption fields. The soil readily absorbs the effluent from the septic tank absorption field, but it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is VIs. The Michigan soil management group is 5a.

15E—Kalkaska sand, 12 to 40 percent slopes. This rolling to steep, somewhat excessively drained soil is on ridges and hills. Individual areas are irregular in shape and range from about 5 to 500 acres.

Typically, the surface layer is black sand about 2 inches thick. The subsurface layer is brown sand about 10 inches thick. The subsoil is multicolored, very friable sand about 36 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, very friable sand. In places the dark reddish brown layer in the upper part of the subsoil is very thin or absent.

Permeability is rapid, available water capacity is low, and surface runoff is slow.

Most areas of this soil are woodland.

The soil is well suited to woodland. Common native trees are sugar maple, American beech, northern red oak, eastern white pine, and red pine. Management concerns are the hazard of erosion, equipment limitations, and seedling mortality. If trees are harvested from the steeper parts of this unit, roads, skid trails, and landings should be located on gentle grades and water should be removed with water bars, culverts, and drop structures to control erosion. The use of ordinary crawler tractors or rubber-tired skidders is limited on steep slopes. Special operations, such as yarding logs uphill with cable, may be needed on steep soils. Seedling mortality caused by droughtiness is a limitation in establishing new stands of trees. Planting containerized seedlings in a well prepared site can reduce seedling mortality. Hand planting may be necessary in the steeper soils.

This soil is not suited to crops or pasture because of steepness of slope and droughtiness. Crops and pasture generally are not grown on this soil.

This soil is poorly suited as sites for buildings on the lower slopes and is unsuitable on the steeper slopes. Poor filtering capacity and slope are limitations for septic tank absorption fields. Buildings can be constructed on the lower slopes of this soil. They should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Installing the distribution lines of septic tank absorption fields across the slope is generally necessary for proper operation. The soil readily absorbs the effluent from the septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is VIIs. The Michigan soil management group is 5a.

16B—Hodenpyl-Karlin complex, 0 to 4 percent slopes. This map unit consists of the nearly level and undulating, well drained Hodenpyl soil and the somewhat excessively drained Karlin soil. Areas of the Hodenpyl and Karlin soils are intermingled on plains. Most of this unit is in one large area making up about 6,300 acres and is very irregular in shape. The Hodenpyl soil and the Karlin soil are each about 48 percent of the unit. These soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Hodenpyl soil is very dark grayish brown sandy loam about 10 inches thick. The subsurface layer is dark brown fine sandy loam about 3 inches thick. The next layer is dark brown, friable sandy loam about 12 inches thick. The subsoil is dark brown, friable sandy loam about 12 inches thick.

Below this to a depth of 60 inches are alternating bands of pale brown sand and strong brown loamy sand.

Typically, the surface layer of the Karlin soil is dark grayish brown loamy fine sand about 9 inches thick. The very friable subsoil is about 20 inches thick. The upper part is dark brown loamy fine sand, and the lower part is brown loamy sand. The underlying material to a depth of about 60 inches is loose, yellowish brown sand.

Included with these soils in mapping are small areas of the more droughty East Lake and Kalkaska soils. These included soils are on plains. They are commonly near the margins of the map unit. They make up about 4 percent of the unit.

Permeability is moderate in the Hodenpyl soil. It is moderately rapid in the upper part of the profile of the Karlin soil and rapid in the lower part. Available water capacity is moderate in the Hodenpyl soil and low in the Karlin soil. Surface runoff is slow on both soils. The surface layer is friable and easily tilled.

Most areas of these soils are in crops. A few areas are in pasture, and a few areas are woodland. These areas are mostly small farm woodlots. Some of the woodland is pine plantations.

These soils are well suited to woodland. They support stands of native hardwoods. Common native trees are sugar maple, American beech, yellow birch, black cherry, eastern hemlock, and northern red oak.

These soils are well suited to crops. They are among the best soils for this use. Corn, small grains, snap beans, and alfalfa-bromegrass for hay are some of the crops commonly grown. The main management concerns are controlling soil blowing, conserving soil moisture, and increasing soil fertility and the content of organic matter. A crop rotation system that includes grasses and legumes for hay help maintain organic matter and control soil blowing. Alternate strips of hay and row crops are commonly used to control erosion. The use of barnyard manure or green manure crops can increase organic matter in the soil. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface conserves soil moisture and controls soil blowing.

These soils are well suited to pasture. Droughtiness is a concern. Proper stocking rates, pasture rotation, and deferment of grazing during dry periods help keep pastures from being overused and depleted.

These soils are well suited as sites for buildings. The Hodenpyl soils are well suited as sites for septic tank absorption fields. The Karlin soil is limited by poor filtering capacity. It readily absorbs the effluent from the septic tank absorption field, but it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies. Septic tank absorption fields should be placed in the Hodenpyl soils where possible.

The land capability classification is IIe. The Michigan soil management groups are 3a and 4a.

17A—Kawkawlin loam, 0 to 4 percent slopes. This nearly level and undulating, somewhat poorly drained soil is on low flats and in drainageways. Individual areas are irregular in shape and range from about 5 to 120 acres.

Typically, the Kawkawlin soil has a surface layer of dark gray loam about 7 inches thick. The next layer is grayish brown and brown, mottled, firm clay loam and silt loam about 5 inches thick. The subsoil is brown, mottled, very firm silty clay loam about 12 inches thick. The underlying material to a depth of about 60 inches is calcareous, dark grayish brown, firm silty clay loam.

Included with this soil in mapping are small areas of the more permeable Allendale and Au Gres soils. These included soils contain more sand than Kawkawlin soil. They are on low flats and in drainageways. They make up 10 to 15 percent of the unit.

Permeability is moderately slow, available water capacity is high, and surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 2 feet from October to May. The surface layer is friable, but the soil tends to form a crust or become puddled after heavy rains.

Most areas of this soil are in hay or pasture. A few areas are in crops, and a few are in woodland.

This soil is well suited to woodland. Common native trees are red maple, sugar maple, northern red oak, paper birch, white spruce, balsam fir, quaking aspen, and eastern hemlock. The main management concern is equipment limitations. The wet, sticky nature of the soil limits the use of equipment during wet periods. Woodland operations should be timed to seasons of the year when the soils are relatively dry or frozen.

This soil is well suited to such crops as corn, small grains, and grass and legumes for hay. Wetness and poor tilth are major management concerns. Artificial drainage is needed if crops are to be grown satisfactorily. In some areas artificial drainage is not practical because of a lack of adequate outlets. Maintaining content of organic matter in the soil by the addition of barnyard manure or green manure crops helps keep the soil soft and friable. Working the soil when it is wet alters soil structure and can cause compaction and puddling.

This soil is well suited to pasture. Grazing livestock when the soil is wet can alter the soil structure and cause compaction. Deferment of grazing during wet periods helps keep the pasture and soil in good condition.

This soil is generally not suitable as sites for buildings because of wetness and the potential for high shrinking and swelling.

The land capability classification is IIw. The Michigan soil management group is 2b.

18—Loxley peat. This nearly level, very poorly drained soil is in bogs. This soil is subject to ponding.

Individual areas are generally rounded and range from about 5 to 400 acres.

Typically, the surface layer is brown peat about 4 inches thick. The subsoil to a depth of about 60 inches is dark reddish brown, friable muck. In places the muck is less than 50 inches thick and is underlain by sand.

Permeability is moderately slow to moderately rapid, available water capacity is high, and surface runoff is very slow. The high water table is near or above the surface during most of the year.

This soil is covered entirely by native sphagnum moss and leatherleaf. It is extremely acid and does not support trees. A high water table, ponding, low strength, and unstable soil material make this soil impractical for most uses.

The land capability classification is VIIw. The Michigan soil management group is Mc-a.

19—Lupton muck. This nearly level, very poorly drained soil is in bogs, depressions, and drainageways. This soil is subject to ponding. Individual areas are irregular in shape and range from about 10 to 1,200 acres.

Typically, the surface layer is very dark brown muck about 5 inches thick. The subsoil to a depth of about 60 inches is very dark brown and very dark grayish brown, friable muck.

Permeability is moderately slow to moderately rapid, available water capacity is high, and surface runoff is very slow. The high water table is near or above the surface during most of the year.

Most areas of this soil are in woodland. Common native trees are northern white-cedar, black spruce, black ash, balsam fir, and quaking aspen. The soil is poorly suited to woodland. Managing this soil for woodland has severe limitations because of wetness and unstable soil material. The major management concerns are equipment limitations, windthrow hazard, and seedling mortality. Harvesting of trees is generally possible only when the soil is frozen. Trees are frequently blown over during windstorms. Harvesting methods should not leave wide spaces between trees. Methods for salvaging windthrown trees should be used where possible. It is extremely difficult to establish new stands of desirable trees on this soil. Expected loss of seedlings is usually more than 50 percent, and replanting is generally not done.

This soil is generally not suitable for crops or pasture because of wetness and instability.

Building site development and septic tank absorption fields are not practical on this soil. The high water table, ponding, and low strength are limitations that are extremely difficult to overcome.

The land capability classification is Vw. The Michigan soil management group is Mc.

20B—Montcalm-Graycalm complex, 0 to 6 percent slopes. This map unit consists of nearly level and undulating, well drained Montcalm soils and somewhat excessively drained Graycalm soils. Areas of Montcalm and Graycalm soils are intermingled on plains and knolls. The map unit is irregular in shape and ranges from about 10 to 700 acres. The Montcalm soil makes up about 45 to 55 percent of the unit, and the Graycalm soil makes up about 30 to 40 percent of the unit. Areas of these soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Montcalm soil is very dark grayish brown loamy sand about 6 inches thick. The next layer to a depth of about 40 inches is strong brown and yellowish brown loamy sand. Below this is mixed reddish brown, friable sandy loam and light brown, very friable loamy sand and light brown, loose sand that has thin bands of loamy sand to a depth of more than 60 inches.

Typically, the surface layer of the Graycalm soil is black sand about 2 inches thick. The subsoil is multicolored, loose sand about 28 inches thick. The next layer is light yellowish brown sand about 20 inches thick. Between depths of 50 and 60 inches are alternate bands of light yellowish brown sand and strong brown loamy sand.

Included with these soils in mapping are small areas of the less permeable Manistee soils and the excessively drained Rubicon soils. The Rubicon soils are more permeable. These soils are on plains and knolls. They make up 12 to 18 percent of the unit.

Permeability is moderately rapid in the Montcalm soil and rapid in the Graycalm soil. Available water capacity is moderate in the Montcalm soil and low in the Graycalm soil. Surface runoff is slow in both soils. The surface layer is friable and easily tilled.

Some areas of these soils are in pasture or are idle. Only a few areas are farmed. Most areas of these soils are woodland. Many areas that were farmed have been planted to pine trees and Christmas trees (fig. 10).

These soils are well suited to woodland. Common native trees are red maple, sugar maple, American beech, northern red oak, bigtooth aspen, eastern white pine, and red pine. Seedling mortality caused by droughtiness hinders the establishment of new stands of trees. Planting containerized seedlings in a well prepared site reduces seedling mortality. The sandy surface in some areas can limit the trafficability of equipment during dry periods.

These soils are fairly well suited to such crops as corn, winter wheat, and hay. Crops that grow best are those that mature early in the season before the available water in the soil is depleted. The main concerns of management of these soils are conserving soil moisture, maintaining content of organic matter and fertility, and controlling soil blowing. Organic matter can be increased by using animal manure or green manure

Figure 10.—Christmas trees are a major crop. Many Scotch pines are grown on the Montcalm-Graycalm complex.

crops. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface helps conserve soil moisture and control soil blowing.

These soils are fairly well suited to pasture. Droughtiness is the major concern. Pastures can dry up during the summer. If the pasture is overgrazed, the soil becomes susceptible to blowing. Proper stocking and rotation of pastures help keep the pasture and the soil in good condition.

These soils are well suited as sites for buildings. The Montcalm soil is well suited to septic tank absorption fields. The Graycalm soil is limited by poor filtering capacity for septic tank absorption fields. It readily absorbs the effluent from septic tank absorption fields but does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IIIs. The Michigan soil management groups are 4a and 5a.

20C—Montcalm-Graycalm complex, 6 to 12 percent slopes. This map unit consists of rolling, well drained Montcalm soils and somewhat excessively drained Graycalm soils. Areas of the Montcalm and Graycalm soils are intermingled on knolls and ridges. The map unit is irregular in shape and ranges from about 10 to 300 acres. The Montcalm soil makes up about 40 to 50 percent of the unit, and the Graycalm soil makes up about 30 to 40 percent of the unit. Areas of these soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Montcalm soil is very dark grayish brown loamy sand about 6 inches thick. The next layer to a depth of about 40 inches is strong brown and yellowish brown loamy sand. Below this is reddish brown, friable sandy loam; light brown, very friable loamy sand; and light brown, loose sand and thin bands of loamy sand to a depth of more than 60 inches.

Typically, the surface layer of the Graycalm soil is black sand about 2 inches thick. The subsoil to a depth of about 28 inches is multicolored, loose sand. The next layer is light yellowish brown sand about 18 inches thick. Between depths of 46 to 60 inches are alternate bands of light yellowish brown sand and strong brown loamy sand.

Included with these soils in mapping are small areas of less permeable Manistee and Nester soils and excessively drained Rubicon soil. The Rubicon soils are more permeable than the Montcalm and Graycalm soils. These soils are on knolls and ridges. The included soils make up 15 to 20 percent of the unit.

Permeability is moderately rapid in the Montcalm soil and rapid in the Graycalm soil. Available water capacity is moderate in the Montcalm soil and low in the Graycalm soil. Surface runoff is slow on both soils.

Most areas of these soils are woodland. Many areas that were once farmed have been planted to pine trees.

These soils are well suited to woodland. Common native trees are red maple, sugar maple, American beech, northern red oak, bigtooth aspen, eastern white pine, and red pine. In areas where new stands of trees are established, seedling mortality is a problem because of droughtiness. Planting containerized seedlings in well prepared sites helps reduce seedling mortality. The sandy surface layer can limit the trafficability of equipment during dry periods.

These soils are poorly suited to crops. Small grains and grass and legumes for hay can be grown. Droughtiness and soil blowing are major management concerns. Yields for cultivated crops and hay are generally low. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface is effective in controlling soil blowing.

Some areas of these soils are used for hay and pasture or are idle. These soils are fairly well suited to pasture. Pastures may dry up during the summer. If the pasture is overgrazed, the soil becomes susceptible to water erosion and soil blowing. Proper stocking, rotation

of pasture, and deferment of grazing during dry periods help keep the pasture and the soil in good condition.

These soils are fairly well suited as sites for buildings. The Montcalm soil is fairly well suited as sites for septic tank absorption fields. Slope is the major limitation. The Graycalm soil is limited by poor filtering capacity for septic tank absorption fields. Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Installing the distribution lines of the septic tank absorption fields across the slope is generally necessary for proper operation. The Graycalm soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IVe. The Michigan soil management groups are 4a and 5a.

20E—Montcalm-Graycalm complex, 12 to 30 percent slopes. This map unit consists of rolling to steep, well drained Montcalm soils and somewhat excessively drained Graycalm soils. Areas of the Montcalm and Graycalm soils are intermingled on hills, knolls, and ridges. Individual areas are irregular in shape and range from about 5 to 300 acres. The Montcalm soil makes up about 40 to 50 percent of the unit, and the Graycalm soil makes up about 30 to 40 percent of the unit. Areas of these soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Montcalm soil is very dark grayish brown loamy sand about 6 inches thick. The next layer to a depth of about 38 inches is strong brown and yellowish brown loamy sand. Below this is reddish brown, friable sandy loam; light brown, very friable loamy sand; and light brown, loose sand and thin bands of loamy sand to a depth of more than 60 inches.

Typically, the surface layer of the Graycalm soil is black sand over dark brown sand about 2 inches thick. The subsoil to a depth of about 26 inches is multicolored, loose sand about 18 inches thick. Between depths of 46 to 60 inches are alternate bands of light yellowish brown sand and strong brown loamy sand.

Included with these soils in mapping are small areas of well drained Nester and Manistee soils. The Nester and Manistee soils are less permeable than the Montcalm and Graycalm soils. These soils are on hills, knolls, and ridges. The included soils make up 15 to 20 percent of the unit.

Permeability is moderately rapid in the Montcalm soil and rapid in the Graycalm soil. Available water capacity is moderate in the Montcalm soil and low in the Graycalm soil. Surface runoff is slow in both soils.

Most of the soils in this unit are woodland. Common native trees are red maple, sugar maple, American beech, northern red oak, bigtooth aspen, eastern white pine, and red pine. These soils are well suited to woodland. The major management concerns are the hazard of erosion, equipment limitation, and high seedling mortality. Slope is a concern in some areas. Where trees are harvested on the steeper parts of this unit, roads, skid trails, and landings should be located on gentle grades and water should be removed with water bars, culverts, and drop structures to control erosion. The use of ordinary crawler tractors or rubber-tired skidders is limited on steep slopes. Special operations, such as yarding logs uphill with cable, may be needed on steep soils. Seedling mortality is a problem if new stands of trees are established. Planting containerized seedlings in a well prepared site helps reduce seedling mortality.

These soils are generally not suited to crops or pasture because of slope and droughtiness. Crops are not grown.

These soils are poorly suited as sites for buildings on the lower slopes but are suited on the higher slopes. In addition, the Graycalm soil has poor filtering capacity for septic tank absorption fields. Buildings can be constructed on the lower slopes of these soils. They should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Installing the distribution lines of septic tank absorption fields across the lower slopes is generally necessary for proper operation. The Graycalm soil readily absorbs the effluent from the septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is VIe. The Michigan soil management groups are 4a and 5a.

21B—Nester sandy loam, 1 to 6 percent slopes. This nearly level and undulating, well drained soil is on plains and knolls. Individual areas are irregular in shape and range from about 5 to 150 acres.

Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsurface layer is brown loam about 3 inches thick. The next layer is mixed brown sandy loam and reddish brown clay loam about 7 inches thick. The subsoil is very firm, dark reddish brown clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is calcareous, reddish brown sandy clay loam and brown clay loam.

Included with this soil in mapping are small areas of somewhat poorly drained Allendale and Kawkawlin soils and sandy Manistee and Montcalm soils. The Manistee and Montcalm soils are more droughty than the Nester soils. The Allendale and Kawkawlin soils are in swales and on small flats. The Manistee and Montcalm soils commonly are on low ridges and knolls, or they are on slightly higher parts of the landscape than the Nester soils. The included soils make up 12 to 15 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Surface runoff is medium. The surface layer is friable, but the soil has a tendency to crust or become puddled after heavy rains, especially in areas where the plow layer contains clayey material from the subsoil.

Most areas of these soils are in crops. Some areas are in hay or pasture. A few areas are woodland. Most wooded areas are small farm woodlots.

This soil is well suited to woodland. Common native trees are sugar maple, American beech, white ash, American basswood, northern red oak, and quaking aspen. There are no major management concerns.

This soil is well suited to such crops as corn, small grains, and alfalfa-bromegrass for hay. The major management concerns are water erosion and maintaining good tilth. Alternate strips of row crops and hay help control water erosion. Conservation tillage that does not invert the soil and leaves part or all of the crop residue on the surface controls erosion and conserves soil moisture. Waterways need to be sodded to prevent gullying. Maintaining content of organic matter by incorporating barnyard manure and green manure crops into the soil helps keep it soft and friable and increases water infiltration. Working the soil when it is wet alters structure and can cause compaction and puddling. This interferes with plant emergence and root growth.

This soil is well suited to pasture. Both grass and legumes grow well. Grazing livestock when the soil is wet alters structure and causes compaction. Timely deferment of grazing during wet periods helps keep the pasture and the soil in good condition.

This soil is fairly well suited as sites for buildings. Shrink-swell potential is a limitation. Backfilling the foundation trench with suitable coarse textured material and diverting drainage away from the building site can prevent damage to the foundation from shrinking and swelling of the soil. This soil also has limitations for septic tank absorption fields because of permeability. Special construction methods, such as enlarged septic tank absorption fields or alternating drain fields, may be needed.

The land capability classification is IIe. The Michigan soil management group is 2a.

21C—Nester sandy loam, 6 to 12 percent slopes. This gently rolling, well drained soil is on ridges and knolls. Individual areas are irregular in shape and range from about 5 to 100 acres.

Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsurface layer is brown loam about 3 inches thick. The next layer is mixed brown sandy loam and reddish brown clay loam about 7 inches thick. The subsoil is very firm, dark reddish brown clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is calcareous, reddish brown sandy clay loam and brown clay loam.

Included with this soil in mapping are small areas of sandy Manistee and Montcalm soils. These soils are more permeable and more droughty than the Nester soils. They are on ridges and knolls. The included soils make up 12 to 15 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Surface runoff is moderately rapid. The surface layer is friable, but the soil has a tendency to crust or become puddled after heavy rains, especially in areas where the plow layer contains clayey material from the subsoil.

Most areas of this soil are in crops, hay, or pasture. A few areas are woodland. Most of these areas are small farm woodlots.

This soil is well suited to woodland. Common native trees are sugar maple, American beech, white ash, American basswood, northern red oak, and quaking aspen. There are no major management concerns.

This soil is fairly well suited to such crops as corn, small grains, and alfalfa-bromegrass for hay. The main management concerns are controlling water erosion and maintaining good tilth. Alternate strips of row crops and hay planted on the contour help control water erosion. Conservation tillage that does not invert the soil and leaves part or all of the crop residue on the surface controls erosion and conserves soil moisture. Waterways need to be sodded to prevent gullying. Maintaining content of organic matter by incorporating barnyard manure and green manure crops into the soil helps keep the soil soft and friable and increases water infiltration. Working the soil when it is wet alters soil structure and causes compaction and puddling. This can interfere with plant emergence and root growth.

This soil is well suited to pasture. Grasses and legumes grow well. If the pasture is overgrazed, the soil becomes susceptible to erosion. Grazing livestock when the soil is wet alters soil structure and causes soil compaction. This increases runoff, and the soil becomes more susceptible to erosion. Proper stocking, rotation of pastures, and deferment of grazing when the soil is wet helps keep the pasture and the soil in good condition.

This soil is fairly well suited as sites for buildings. Slope and shrink-swell potential are the major limitations. The soil is poorly suited to septic tank absorption fields because of the moderately slow permeability. Buildings constructed on this soil should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Damage to building foundations from shrinking and swelling of the soil can be prevented by widening and backfilling the foundation trench with suitable coarse textured soil material and by diverting water away from the building site. Special construction methods, such as enlarging septic tank absorption fields or installing alternating drainage fields, can overcome the permeability limitation.

The land capability classification is IIIe. The Michigan soil management group is 2a.

21E—Nester loam, 12 to 40 percent slopes. This rolling to steep, well drained soil is on hills and on steep side slopes adjacent to flood plains. Individual areas are irregular or elongated in shape and range from about 5 to 100 acres.

Typically, the surface layer is dark grayish brown loam about 5 inches thick. The subsurface layer is brown loam about 2 inches thick. The next layer is brown, reddish brown, and dark reddish brown, firm clay loam about 16 inches thick. The underlying material to a depth of about 60 inches is reddish brown, calcareous, firm clay loam.

Included with this soil in mapping are small areas of sandy Manistee and Montcalm soils. These soils are more permeable and more droughty than the Nester soils. They are on hills and side slopes and make up 12 to 15 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Surface runoff is rapid.

Some areas of this soil are in pasture. Most areas are woodland.

The soil is well suited to woodland. Common native trees are sugar maple, American beech, white ash, American basswood, northern red oak, and quaking aspen. The major management concerns are the hazard of erosion and equipment limitation because of slope. Roads, skid trails, and landings should be located on gentle grades and water should be removed with water bars, culverts, and drop structures to control erosion.

This soil is generally not suited to crops. Slope and water erosion are major management concerns.

This soil is fairly well suited to pasture. Grasses and legumes grow well. If the pasture is overgrazed, the soil becomes susceptible to erosion. Grazing livestock when the soil is wet alters structure and causes compaction. This increases runoff and the soil becomes more susceptible to erosion. Proper stocking rates, rotation of pastures, and deferment of grazing when the soil is wet help keep the pasture and the soil in good condition.

This soil is unsuitable as sites for buildings because of slope, shrink-swell potential, and permeability limitations. The limitations are difficult to overcome.

The land capability classification is VIe. The Michigan soil management group is 2a.

22—Tawas-Roscommon association. This map unit consists of nearly level, very poorly drained soils in drainageways and bogs. These soils are subject to ponding. Roscommon soils are generally on the edges of the unit. Tawas soils generally are in the center. Individual areas are elongated or irregular in shape and range from about 5 to 800 acres. Some areas of this unit are predominantly Tawas soil, and other areas are predominantly Roscommon soil. Both soils are present in most areas.

Typically, the surface layer of Tawas soil is black muck about 12 inches thick. The subsoil is black and very dark gray, friable muck about 29 inches thick. The underlying material to a depth of about 60 inches is light brownish gray, loose sand. In places the muck layer is more than 50 inches thick. In a few places the underlying material is clayey.

Typically, the surface layer of Roscommon soil is very dark gray, mucky sand about 9 inches thick. The underlying material to a depth of about 60 inches is light brownish gray and brown, loose sand. In a few places clayey material is near the surface.

Included with these soils in mapping are small areas of somewhat poorly drained Au Gres soils on slightly elevated mounds and ridges. The included soils make up 5 to 10 percent of the unit.

Permeability in the Tawas soil is moderately slow to moderately rapid in the upper part and rapid in the lower part. Available water capacity is high. Permeability in the Roscommon soil is rapid, and available water capacity is low. Surface runoff is very slow in both soils. The high water table is near or above the surface during most of the year.

Most areas of these soils are woodland. Common native trees are northern white-cedar, black spruce, red maple, balsam fir, black ash, and quaking aspen. These soils are poorly suited to woodland. The use of equipment, seedling mortality, and windthrow hazard are major concerns because of wetness and unstable soil material. Harvesting trees is generally possible only when the ground is frozen. Trees are frequently blown over during windstorms, especially in areas of muck soils. Harvesting methods should not leave wide spaces between trees. Windthrown trees should be salvaged where possible. Establishing new stands of desirable trees on these soils is very difficult. Expected loss of seedlings generally is more than 50 percent, and seedlings are generally not replanted.

These soils are generally not suited to crops or pasture.

Buildings and septic tank absorption fields are not practical on these soils. The high water table and ponding are limitations that are very difficult to overcome.

The land capability classification is VIw. The Michigan soil management groups are M/4c and 5c.

23B—Rubicon sand, 0 to 12 percent slopes. This nearly level to gently rolling, excessively drained soil is on plains, ridges, and knolls. Individual areas are irregular in shape and range from about 10 to 700 acres.

Typically, the surface layer is black sand about 2 inches thick. The subsurface layer is pinkish gray sand about 8 inches thick. The subsoil is very friable sand about 33 inches thick. The upper part is dark brown, the middle part is yellowish brown, and the lower part is brownish yellow. The underlying material to a depth of about 60 inches is very pale brown, loose sand. In some areas a few thin bands of loamy sand are in the subsoil or the underlying material.

Included with this soil in mapping are small areas of less droughty, moderately well drained Croswell soils and well drained Manistee and Montcalm soils. The Croswell soils are in swales and on low flats. They are adjacent to streams, bogs, and lakes. The Manistee and Montcalm soils are on plains, ridges, and knolls. The included soils make up 8 to 12 percent of the unit.

Permeability is rapid, available water capacity is low, and surface runoff is slow.

Most areas of this soil are woodland. Common native trees are red maple, northern red oak, eastern white pine, red pine, and bigtooth aspen. Many woodland areas that once were cleared are now in pine plantations (fig. 11). This Rubicon soil is fairly well suited to woodland. The high seedling mortality and equipment limitations are the major management concerns. Seedling mortality caused by droughtiness is a problem in areas where new stands of trees are established. Planting containerized seedlings in well prepared sites helps reduce seedling mortality. The sandy surface layer can limit the trafficability of equipment during dry periods.

This soil generally is not suited to crops or pasture. Droughtiness and erosion are the major management concerns (fig. 12).

This soil is fairly well suited as sites for buildings but is poorly suited as sites for septic tank absorption fields. The steeper slopes are a limitation for these uses. Poor filtering capacity is a limitation for septic tank absorption fields. Buildings constructed on the higher slopes should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Installing the distribution lines of septic tank absorption fields across the higher slopes is generally necessary for proper operation. The soil readily absorbs the effluent from the septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in pollution of ground water supplies.

The land capability classification is VIs. The Michigan soil management group is 5.3a.

23E—Rubicon sand, 12 to 40 percent slopes. This rolling to steep, excessively drained soil is on hills and ridges. Individual areas are irregular in shape and range from about 5 to 200 acres.

Typically, the surface layer is black sand about 2 inches thick. The subsurface layer is pinkish gray sand about 8 inches thick. The upper part is dark brown, the middle part is yellowish brown, and the lower part is brownish yellow. The underlying material to a depth of about 60 inches is very pale brown, loose sand. In some areas a few thin bands of loamy sand are in the subsoil and underlying material.

Included with this soil in mapping are small areas of less droughty, moderately well drained Croswell soils and well drained Manistee and Montcalm soils. The Croswell soils are in swales. The Manistee and Montcalm soils are on hills and ridges. The included soils make up 8 to 12 percent of the unit.

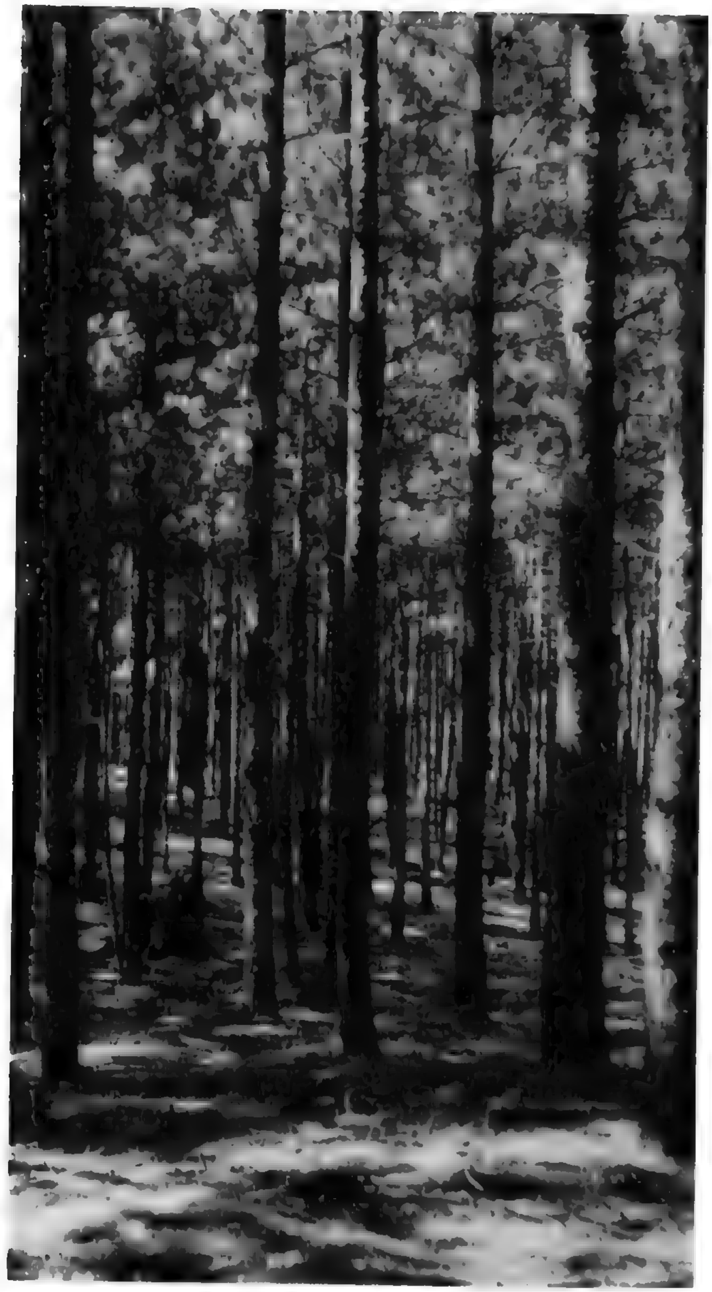


Figure 11.—This well managed red pine plantation on Rubicon sand produces high yields.

Permeability is rapid, available water capacity is low, and surface runoff is slow.

Most areas of this soil are woodland. Common native trees are red maple, northern red oak, eastern white pine, red pine, and bigtooth aspen. Many areas that once were cleared are now in pine plantations. This soil

Figure 12.—Many areas of droughty Rubicon sand, 0 to 12 percent slopes, that were once farmed have been planted to pine trees. Other areas are idle.

is fairly well suited to woodland. Management concerns are seedling mortality, the hazard of erosion, and equipment limitations. Planting containerized seedlings in a well prepared site reduces seedling mortality. Seedling mortality caused by droughtiness is a concern in areas where new stands of trees are established. Slope is an additional concern in some areas. Roads, skid trails, and landings should be located on gentle grades, and water should be removed with water bars, culverts, and drop structures to control erosion. The use of ordinary crawler tractors or rubber-tired skidders is limited on steep slopes. Special operations, such as yarding logs uphill with cable, may be needed.

This soil is not suited to crops or pasture because of droughtiness, erosion, and slope.

This soil is poorly suited as sites for buildings and septic tank absorption fields on the lower slopes and is not suited on the steeper slopes. Slope is a limitation. Poor filtering capacity for septic tank absorption fields is an additional serious limitation. Buildings can be constructed on the lower slopes of this soil. Land shaping may be necessary in some areas. Installing the distribution lines of septic tank absorption fields across the lower slopes is generally necessary for proper operation. The soil readily absorbs the effluent from the septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is VIIs. The Michigan soil management group is 5.3a.

24D—Rubicon sand, 12 to 40 percent slopes, severely eroded. This rolling to steep, excessively drained soil is on knolls, hills, and ridges. Individual areas are generally rounded in shape and range from about 3 to 50 acres.

Typically, the surface layer is yellowish brown sand about 2 inches thick. The subsoil is brownish yellow sand about 24 inches thick. The underlying material to a depth of 60 inches is pale brown, loose sand. Many pebbles and cobbles are on the surface in some areas. Some loamy soil material is on the surface in places.

Included with this soil in mapping are small areas of slightly eroded Graycalm, Kalkaska, Montcalm, and Rubicon soils.

A few areas of this soil are nearly bare of plant cover, but most areas have been stabilized by planted pine trees (fig. 13). This soil is suitable for woodland products, but it has severe limitations for most other land uses. Onsite investigation is needed to determine the suitability of this soil for development.

The land capability classification is VIIs. The Michigan soil management group is 5.3a.

25—Pits. This map unit consists of open excavations. The original soil material has been excavated. The pits range from about 3 to 70 acres and range in depth from

Figure 13.—Planting trees helps control soil blowing on Rubicon sand, 12 to 40 percent slopes, severely eroded.

about 5 feet to 50 feet or more. The sides of the pits are very steep. Some pits have been excavated below the water table and have shallow pools of water in the bottoms much of the time.

The exposed materials vary widely in texture. These areas support little or no plant cover. Permeability and available water capacity are too variable to rate. Onsite investigation is needed to determine the potential of these areas for development.

Not assigned to a capability subclass or to a Michigan soil management group.

26B—Manistee-Montcalm loamy sands, 0 to 6 percent slopes. This map unit consists of nearly level and undulating, well drained soils. Areas of the Manistee and Montcalm soils are intermingled on plains and knolls. This map unit is irregular in shape and ranges from about 5 to 250 acres. The Manistee soil makes up about 50 to 60 percent of the unit, and the Montcalm soil makes up about 20 to 30 percent of the unit. These soils are so intricately mixed or so small that mapping them separately is not practical.

Typically, the surface layer of the Manistee soil is very dark gray loamy sand and brown loamy sand about 4 inches thick. The upper part of the subsoil is very friable, reddish brown and brown loamy sand and strong brown sand about 14 inches thick. The next layer is mixed brown loamy sand and reddish brown sandy clay loam about 23 inches thick. The lower part of the subsoil is brown, very firm clay about 6 inches thick. The underlying material to a depth of about 60 inches is calcareous, brown, firm clay.

Typically, the surface layer of the Montcalm soil is dark brown loamy sand about 7 inches thick. The next layer to a depth of about 42 inches is brown and dark yellowish brown loamy sand. Below this is mixed brown, friable sandy loam and brown, very friable loamy sand to a depth of more than 60 inches.

Included with these soils in mapping are small areas of somewhat poorly drained Allendale soils, somewhat excessively drained Kalkaska soils, and loamy Nester soils. Kalkaska soils are more droughty than Manistee and Montcalm soils, and Nester soils are less permeable. The Allendale soil is in swales and on low flats. The Kalkaska and Nester soils are on plains and knolls. The included soils make up 15 to 20 percent of the unit.

Permeability in the Manistee soil is rapid in the upper part of the profile and slow in the lower part. Permeability in the Montcalm soil is moderately rapid. Available water capacity is moderate, and surface runoff is slow. The surface layer is very friable and easily tilled.

Many areas of these soils are in hay or pasture. A few areas are in crops. Many areas are woodland.

These soils are well suited to woodland. Common native trees are sugar maple, yellow birch, American beech, red maple, northern red oak, white ash, eastern white pine, and red pine. Seedling mortality is a concern in areas where new stands of trees are established. Planting containerized seedlings in a well prepared site reduces seedling mortality.

These soils are fairly well suited to such crops as corn, small grains, and grasses and legumes for hay. The main management concerns are conserving soil moisture, controlling soil blowing, and providing organic matter. A crop rotation system that includes grasses and legumes helps increase organic matter content and control soil blowing. Organic matter can be increased by incorporating barnyard manure and green manure crops into the soil. Using alternate strips of hay and row crops helps control soil blowing. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface is an important practice that conserves soil moisture and controls soil blowing.

These soils are fairly well suited to hay and pasture. Pasture tends to dry up during the summer. Proper stocking rates, rotation of pastures, and timely deferment of grazing during dry periods help keep the pasture in good condition.

These soils are well suited as sites for buildings. The Montcalm soil is well suited as sites for septic tank absorption fields, but the Manistee soil is poorly suited. Special construction, such as enlarged drainage fields, or alternating the drainage fields may be needed to overcome the slow permeability in the lower part of the Manistee soil.

The land capability classification is IIIs. The Michigan soil management groups are 4/1a and 4a.

26C—Manistee-Montcalm loamy sands, 6 to 12 percent slopes. This map unit consists of gently rolling, well drained soils. Areas of the Manistee and Montcalm soils are intermingled on ridges and knolls. This map unit is irregular in shape and ranges from about 5 acres to 100 acres. The Manistee soil makes up about 50 to 60 percent of the unit, and the Montcalm soil makes up about 20 to 30 percent of the unit. These soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Manistee soil is very dark gray loamy sand and brown loamy sand about 4 inches thick. The upper part of the subsoil is very friable, reddish brown and brown loamy sand and strong brown sand about 14 inches thick. The next layer is mixed brown loamy sand and reddish brown sandy clay loam about 23 inches thick. The lower part of the subsoil is brown, very firm clay about 6 inches thick. The underlying material to a depth of about 60 inches is calcareous, brown, firm clay.

Typically, the surface layer of Montcalm soil is dark brown loamy sand about 7 inches thick. The next layer to a depth of about 40 inches is brown and dark yellowish brown loamy sand. The next layer is mixed

brown, friable sandy loam and brown, very friable loamy sand to a depth of more than 60 inches.

Included with these soils in mapping are small areas of somewhat poorly drained Allendale soils, somewhat excessively drained Kalkaska soils, and Nester soils. Kalkaska soils are more droughty than Manistee and Montcalm soils. The Nester soils are less permeable. The Allendale soils are in swales. The Kalkaska and Nester soils are on ridges and knolls. The included soils make up 15 to 20 percent of the unit.

Permeability in the Manistee soil is rapid in the upper part and slow in the lower part. Permeability in the Montcalm soil is moderately rapid. Available water capacity is moderate, and surface runoff is slow. The surface layer is very friable and easily tilled.

A few areas of these soils are in crops or pasture. Many areas are woodland.

These soils are well suited to woodland. Common native trees are sugar maple, yellow birch, American beech, red maple, northern red oak, white ash, eastern white pine, and red pine. Seedling mortality is a moderate concern in areas where new stands of trees are established. Planting containerized seedlings in well prepared sites reduces seedling mortality.

These soils are fairly well suited to such crops as corn, small grains, and grasses and legumes for hay. The major management concerns are conserving soil moisture, controlling soil blowing and water erosion, and increasing content of organic matter. Alternate strips of hay and row crops laid out on the contour help control water erosion. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface is an important practice that conserves soil moisture and controls soil blowing and water erosion. A crop rotation system that includes grasses and legumes helps increase organic matter content and control soil blowing. Organic matter can be increased by incorporating barnyard manure and green manure crops into the soil.

These soils are fairly well suited to hay and pasture. Pastures tend to dry up during the summer months. Proper stocking rates, rotation of pastures, and timely deferment of grazing help control erosion and soil blowing.

These soils are fairly well suited as sites for buildings. The Manistee soil is poorly suited as sites for septic tank absorption fields because of slow permeability and slope. The Montcalm soil is fairly well suited. Slope is a limitation. Buildings constructed on these soils should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Installing the distribution lines of absorption fields across the slope is generally necessary for proper operation. In the Manistee soils, special construction, such as enlarged drainage fields or alternating drainage fields, may be needed to overcome the slow permeability in the lower part of the profile.

The land capability classification is IIIe. The Michigan soil management groups are 4/1a and 4a.

28C—Dighton loam, 6 to 12 percent slopes. This gently rolling, well drained soil is on knolls and short, uneven side slopes. Individual areas are irregular in shape and range from about 5 to 100 acres.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The next layer is mixed brown clay loam and pale brown loam about 7 inches thick. The subsoil is about 16 inches thick. It is reddish brown, very firm clay loam in the upper part and brown, firm clay loam in the lower part. The underlying material to a depth of about 60 inches is brown sandy loam in the upper part and dark yellowish brown sand in the lower part.

Included with this soil in mapping are small areas of somewhat poorly drained Kawkawlin soils and more permeable Montcalm soils. The Kawkawlin soils are in small depressions and flats. The sandy Montcalm soils are dominantly on the tops of low ridge and knolls. The included soils make up 10 to 15 percent of the unit.

Permeability is moderately slow in the upper part of this Dighton soil and rapid in the lower part. Surface runoff is moderately rapid, and available water capacity is moderate. The surface layer is generally friable. This soil has a tendency to crust and become puddled after heavy rains, especially in areas where the plow layer contains clayey material from the subsoil.

Most areas of this soil are in hay or pasture. Some areas are in crops.

This soil is well suited to woodland. There are no major management concerns.

This soil is fairly well suited to such crops as corn and small grains. The major management concerns are water erosion and soil tilth. Planting alternate strips of hay and row crops on the contour helps control erosion. Conservation tillage that does not invert the soil and leaves all or part of the crop residue on the surface helps conserve soil moisture and control erosion. Organic matter can be increased by incorporating barnyard manure and green manure crops into the soil. This practice improves soil structure and tilth.

The soil is well suited to hay or pasture. The main management concerns are controlling erosion and maintaining the organic matter for good tilth. Proper stocking of grazing animals and rotation of pastures help prevent overgrazing, which exposes the soil to erosion. Grazing when the soil is wet can alter soil structure and cause compaction. This can increase runoff and make the soil more susceptible to erosion.

This soil is fairly well suited as sites for buildings, but it is poorly suited as sites for septic tank absorption fields. Shrink-swell potential and slope are limitations for building construction. Moderately slow permeability in the upper part of the soil, poor filtering capacity in the lower part, and slope are limitations for septic tank absorption

fields. The upper layers of soil need to be replaced with more permeable fill material to offset the shrink-swell potential and to provide suitable material for the absorption fields. The slope can be reshaped by cutting and filling or by using retaining walls. The underlying soil material readily absorbs the effluent from the septic tank absorption fields but it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IIIe. The Michigan soil management group is 2.5a.

29B—Graycalm-Grayling sands, 0 to 6 percent slopes. This map unit consists of nearly level and undulating, somewhat excessively drained Graycalm soils and excessively drained Grayling soils. Areas of Graycalm and Grayling soils are intermingled on broad plains. This map unit ranges from about 600 acres to several square miles. The Graycalm soil makes up about 75 percent of the unit, and the Grayling soil makes up about 20 percent of the unit. These soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Graycalm soil is black sand about 2 inches thick. The subsoil to a depth of about 26 inches is multicolored, loose sand. The next layer is light yellowish brown sand about 18 inches thick. Between depths of 46 to 60 inches are alternate bands of light yellowish brown sand and strong brown loamy sand.

Typically, the surface layer of Grayling soil is black sand about 2 inches thick. The subsoil is dark yellowish brown and yellowish brown, loose sand about 24 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, loose sand.

Included with these soils in mapping are small areas of moderately well drained Croswell soils. The Croswell soils are in swales and on flats adjacent to lakes and ponds. The included soils make up 2 to 5 percent of the unit.

Permeability is rapid, surface runoff is slow, and available water capacity is low.

Most areas of these soils are woodland. Northern red oak, jack pine, and red pine are common. These soils are fairly well suited to trees. Seedling mortality and equipment limitation are the major management concerns. The soils are sandy and droughty. Planting containerized seedlings in well prepared sites reduces seedling mortality. The sandy surface of these soils can limit the trafficability of equipment during dry periods.

These soils are not suited to crops because of droughtiness and soil blowing. They are not used for crops or pasture.

These soils are well suited as sites for buildings. They are limited as sites for septic tank absorption fields by poor filtering capacity. The soils readily absorb the effluent from septic tank absorption fields, but they do not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is VIs. The Michigan soil management groups are 5a and 5.7a.

29D—Graycalm-Grayling sands, 6 to 30 percent slopes. This map unit consists of gently rolling to moderately steep, somewhat excessively drained Graycalm soils and excessively drained Grayling soils. Areas of Graycalm and Grayling soils are intermingled on knolls and hills. This map unit is irregular in shape and ranges from about 10 to 200 acres. The Graycalm soil makes up about 60 to 70 percent of the unit, and the Grayling soil makes up about 20 to 25 percent of the unit. These soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Graycalm soil is black sand about 2 inches thick. The subsoil to a depth of about 26 inches is multicolored, loose sand. The next layer is light yellowish brown sand about 18 inches thick. Between depths of 46 to 60 inches are alternate bands of light yellowish brown sand and strong brown loamy sand.

Typically, the surface layer of the Grayling soil is black sand about 2 inches thick. The subsoil is dark yellowish brown and yellowish brown, loose sand about 24 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, loose sand.

Included with these soils in mapping are small areas of moderately well drained Croswell soils. These soils are less droughty than the Graycalm and Grayling soils. The Croswell soils are in swales. The included soils make up 5 to 10 percent of the unit.

Permeability is rapid, surface runoff is slow to medium, and available water capacity is low.

Most areas of these soils are woodland. Northern red oak, jack pine, and red pine are common. These soils are fairly well suited to trees. Seedling mortality and equipment limitations are the major management concerns. Because the soils are sandy and droughty, establishing new stands of trees is difficult. The planting of containerized seedlings in a well prepared site reduces seedling mortality. The sandy surface of these soils can limit trafficability of equipment during dry periods.

These soils are not suited to farming because of droughtiness and soil blowing. They are not used for crops.

The soils of this unit are fairly well suited as sites for buildings on slopes of less than 15 percent. They are not generally suited to steeper slopes. Slope and poor filtering capacity are the major limitations for septic tank absorption fields. Buildings constructed on the lower slopes of this soil should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Installing the distribution lines of septic tank

absorption fields across the slope is generally necessary for proper operation. These soils readily absorb effluent, but they do not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is VIs. The Michigan soil management groups are 5a and 5.7a.

30B—Kalkaska-East Lake sands, 0 to 6 percent slopes. This map unit consists of nearly level and undulating, somewhat excessively drained soils. Areas of Kalkaska and East Lake soils are intermingled on broad plains. This map unit is irregular in shape and ranges from about 5 acres to 200 acres. The Kalkaska soil makes up about 50 to 60 percent of the unit, and the East Lake soil makes up about 30 to 35 percent of the unit. These soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Kalkaska soil is black sand about 2 inches thick. The subsurface layer is brown sand about 10 inches thick. The subsoil is multicolored, very friable sand about 36 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, very friable sand. In places the dark reddish brown layer in the upper part of the subsoil is very thin or absent.

Typically, the surface layer of the East Lake soil is very dark grayish brown sand about 4 inches thick. The subsoil is brown and yellowish brown, very friable sand about 17 inches thick. The underlying material to a depth of about 60 inches is calcareous, dark yellowish brown gravelly sand in the upper part and yellowish brown very gravelly sand in the lower part.

Included with these soils in mapping are small areas of well drained Montcalm soils. The Montcalm soils are less permeable than the Kalkaska and East Lake soils. They are on broad plains. The included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Kalkaska soil and very rapid in the East Lake soil. Available water capacity is low. Surface runoff is slow.

Most areas of these soils are woodland. Some areas are in pasture or are idle. Many areas that once were cleared are now in pine plantations.

These soils are well suited to woodland. Common native trees are sugar maple, northern red oak, quaking aspen, red pine, and eastern white pine. Seedling mortality and equipment limitations are the major management concerns. Planting containerized seedlings in well prepared sites reduces seedling mortality. The sandy surface can limit the trafficability of equipment during dry periods.

These soils are poorly suited to crops. Major limitations are droughtiness and soil blowing. Small grains and grasses and legumes for hay can be grown.

The soils are poorly suited to pasture. Pastures dry up during the summer. If pastures are overgrazed, the soil becomes susceptible to blowing. Proper stocking rates, rotation of pastures, and deferment of grazing during dry periods help keep pastures in good condition.

These soils are well suited as sites for buildings. Poor filtering capacity is a limitation for septic tank absorption fields. These soils readily absorb the effluent from septic tank absorption fields, but they do not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IVs. The Michigan soil management group is 5a.

30C—Kalkaska-East Lake sands, 6 to 12 percent slopes. This map unit consists of gently rolling, somewhat excessively drained soils. Areas of the Kalkaska and East Lake soils are intermingled on ridges and knolls. This map unit is irregular in shape and ranges from about 10 acres to 100 acres. The Kalkaska soil makes up about 50 to 60 percent of the unit, and the East Lake soil makes up about 25 to 35 percent of the unit. These soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Kalkaska soil is black sand about 2 inches thick. The subsurface layer is brown sand about 10 inches thick. The subsoil is multicolored, very friable sand about 36 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, very friable sand. In places the dark reddish brown layer in the upper part of the subsoil is very thin or absent.

Typically, the surface layer of the East Lake soil is very dark grayish brown sand about 4 inches thick. The subsoil is brown and yellowish brown, very friable sand about 17 inches thick. The underlying material to a depth of about 60 inches is calcareous, dark yellowish brown gravelly sand in the upper part and light yellowish brown very gravelly sand in the lower part.

Included with these soils in mapping are small areas of the well drained Montcalm soils. The Montcalm soils are less permeable than the Kalkaska and East Lake soils. The Montcalm soils are on ridges and knolls. The included soils make up 5 to 10 percent of the unit.

Permeability is rapid in the Kalkaska soil and very rapid in the East Lake soil. Available water capacity is low, and surface runoff is slow.

Most areas of these soils are woodland. A few areas are in pasture.

The soils are well suited to woodland. Common native trees are sugar maple, American beech, yellow birch, northern red oak, quaking aspen, red pine, and eastern white pine. Seedling mortality and equipment limitations are the major management concerns. Planting containerized seedlings in well prepared sites reduces seedling mortality. The sandy surface limits the trafficability of equipment during dry periods.

These soils are unsuitable for crops. Because of droughtiness and soil blowing, crops generally are not

grown. These soils are poorly suited to pasture because of droughtiness. Pastures dry up during the summer and, if overgrazed, are susceptible to soil blowing. Proper stocking rates, rotation of pastures, and timely deferment of grazing during dry periods help keep pastures and soil in good condition.

These soils have fair suitability as sites for buildings and septic tank absorption fields. Slope is a concern for buildings. Slope and poor filtering capacity are concerns for septic tank absorption fields. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be necessary in some areas for buildings and septic tanks. Installing the distribution lines of septic tank absorption fields across the slope is generally necessary for proper operation. These soils readily absorb the effluent from septic tank absorption fields, but they do not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is VIs. The Michigan soil management group is 5a.

30E—Kalkaska-East Lake sands, 12 to 30 percent slopes. This map unit consists of rolling to moderately steep, somewhat excessively drained soils. Areas of the Kalkaska and East Lake soils are intermingled on hills and ridges. This map unit is irregular in shape and ranges from about 10 to 300 acres. The Kalkaska soil makes up about 50 to 60 percent of the unit, and the East Lake soil makes up about 30 to 35 percent of the unit. These soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Kalkaska soil is black sand about 2 inches thick. The subsurface layer is brown sand about 10 inches thick. The subsoil is multicolored, very friable sand about 32 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown, very friable sand. In some places the dark reddish brown layer in the upper part of the subsoil is very thin or absent.

Typically, the surface layer of the East Lake soil is very dark grayish brown sand about 4 inches thick. The subsoil is brown and yellowish brown, very friable sand about 17 inches thick. The underlying material to a depth of about 60 inches is calcareous, dark yellowish brown gravelly sand in the upper part and light yellowish brown very gravelly sand in the lower part.

Included with these soils in mapping are small areas of well drained Montcalm soils. The included soils are less permeable than the Kalkaska and East Lake soils. The Montcalm soils are on hills and ridges. They make up 5 to 10 percent of the unit.

Permeability is rapid in the Kalkaska soil and very rapid in the East Lake soil. Available water capacity is low, and surface runoff is slow.

Almost all areas of these soils are woodland. Some of these areas that were previously cleared are in pine plantations.

These soils are well suited to woodland. Common native trees are sugar maple, northern red oak, quaking aspen, red pine, and eastern white pine. Slope is a serious problem in some areas. Major management concerns are the hazard of erosion, equipment limitations, and seedling mortality. Roads, skid trails, and landings should be located on gentle grades to overcome the limitations, and water should be removed with water bars, culverts, and drop structures to control erosion. The use of ordinary crawler tractors or rubber-tired skidders is limited on steep slopes. Special operations, such as yarding logs uphill with a cable, may be needed. Planting containerized seedlings in a well prepared site reduces seedling mortality. Hand planting may be necessary on the steeper soils.

These soils are generally not used for crops and pasture because of slope and droughty conditions.

These soils are poorly suited as sites for buildings and septic tank absorption fields on the lower slopes and are not suited on the steeper slopes. Slope is a major limitation. Poor filtering capacity is a serious limitation for septic tank absorption fields. Buildings constructed on the lower slopes should be designed to conform to the natural slope of the land. Land shaping may be necessary in some areas. Installing the distribution lines of septic tank absorption fields across the slope is generally necessary for proper operation. The soils readily absorb the effluent from the septic tank absorption fields, but they do not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is VIIs. The Michigan soil management group is 5a.

34—Winterfield sand. This nearly level, somewhat poorly drained soil is on flood plains. This soil is subject to frequent flooding. Individual areas are elongated in shape and range from about 5 to 360 acres.

Typically, the surface layer is very dark gray sand about 8 inches thick. The underlying material to a depth of about 60 inches is multicolored, loose sand and loamy sand. Layers of gravel and cobbles in the underlying material are common in some areas.

Included with this soil in mapping are small areas of the moderately well drained Croswell soils and the very poorly drained Roscommon and Tawas soils. The Croswell soils are on low ridges and mounds. The Roscommon and Tawas soils are in oxbows and depressions. The included soils make up 10 to 15 percent of the unit.

Permeability is rapid, available water capacity is low, and surface runoff is slow. The seasonal high water table is at a depth of 1 foot to 2 feet from November to May.

Almost all areas of this soil are woodland. Common native trees are red maple, paper birch, white spruce, balsam fir, quaking aspen, and eastern white pine. This soil is fairly well suited to woodland. Accessibility is a serious problem because the soil is cut into many small areas on the flood plain by meandering rivers. Frequent flooding is a hazard that hinders logging operations.

This soil is not suited to crops or pasture because of frequent flooding, and it is not suited as sites for buildings and septic tank absorption fields because of wetness and flooding.

The land capability classification is VIIw. The Michigan soil management group is L-4c.

35B—Mancelona-East Lake complex, 0 to 6 percent slopes. This map unit consists of nearly level and undulating, somewhat excessively drained soils. Areas of the Mancelona and East Lake soils are intermingled on broad plains. This map unit is irregular in shape and ranges from about 10 to 300 acres. The Mancelona soil makes up about 40 to 50 percent of the unit, and the East Lake soil makes up about 35 to 45 percent of the unit. These soils are so intricately mixed or so small in size that mapping them separately is not practical.

Typically, the surface layer of the Mancelona soil is very dark gray loamy sand about 5 inches thick. The subsurface layer is dark brown sand about 2 inches thick. The next part is dark reddish brown and brown, very friable sand and brown, very friable gravelly sand about 17 inches thick. Below this is yellowish brown, friable gravelly sand. The lower part of the subsoil is dark reddish brown gravelly sandy loam. The underlying material to a depth of about 60 inches is calcareous, yellowish brown very gravelly sand.

Typically, the surface layer of the East Lake soil is very dark grayish brown sand about 4 inches thick. The subsoil is brown and yellowish brown, very friable sand about 17 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown, calcareous gravelly sand over yellowish brown very gravelly sand. In places the underlying material is not calcareous and is neutral or slightly acid. In a few places the underlying material is loamy or clayey.

Permeability is moderately rapid in the upper part of the Mancelona soil and very rapid in the lower part. Permeability is very rapid in the East Lake soil. Available water capacity is low, and runoff is slow.

Most areas of these soils are woodland. Some areas that once were cleared are now in pine plantations. These soils are fairly well suited to woodland. Seedling mortality is a major management concern. The use of high quality planting stock helps the survival of seedlings.

These soils are poorly suited to crops. Droughtiness is a major concern. Small grains and grasses and legumes for hay can be grown. The use of cover crops, green manure crops, crop residue, and barnyard manure help conserve moisture.

These soils are poorly suited to pasture. Pastures dry up during the summer. If pastures are overgrazed, the soil becomes susceptible to blowing. Proper stocking, rotation of pastures, and deferment of grazing during dry periods help keep the pastures in good condition.

These soils are well suited as sites for buildings, but they have poor filtering capacity for septic tank absorption fields. The soils readily absorb the effluent from septic tank absorption fields, but they do not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IVs. The Michigan soil management groups are 4a and 5a.

36B—Kalkaska sand, banded sustratum, 0 to 6 percent slopes. This nearly level and undulating, well drained soil is on flats and swales between hills. Individual areas are irregular in shape and range from about 10 to 300 acres.

Typically, the surface layer is very dark grayish brown sand about 2 inches thick. The subsurface layer is brown sand about 7 inches thick. The subsoil is multicolored, very friable sand about 41 inches thick. The underlying material is brown sand. At a depth of 60 to 120 inches or more bands and layers are reddish brown loam, sandy loam, loamy fine sand, and silty clay. In places the dark reddish brown layer in the upper part of the subsoil is very thin or absent.

Included with this soil in mapping are small areas of the less permeable Allendale, Emmet, Manistee, and Montcalm soils. These soils are on flats and swales between hills. The included soils make up 15 to 20 percent of the unit.

Permeability is rapid, available water capacity is low, and surface runoff is slow.

Most areas of this soil are woodland. The soil is well suited to woodland. Common native trees are sugar maple, American beech, yellow birch, northern red oak, white ash, black cherry, and eastern white pine. Deep-rooted species, such as northern red oak, grow especially well in this soil. Seedling mortality and equipment limitations caused by sandiness are major management concerns. Planting containerized seedlings in well prepared sites reduces seedling mortality. The sandy surface can limit the trafficability of equipment during dry periods.

This soil is poorly suited to cultivated crops or pasture. Crops are generally not grown.

This soil is well suited as sites for buildings, but it has poor filtering capacity for septic tank absorption fields. This soil readily absorbs the effluent from septic tank absorption fields, but it does not filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is IVs. The Michigan soil management group is 5a.

36C—Kalkaska sand, banded substratum, 6 to 12 percent slopes. This gently rolling, well drained soil is on knolls and foot slopes of hills. Individual areas are irregular in shape and range from about 10 to 50 acres.

Typically, the surface layer is very dark grayish brown sand about 2 inches thick. The subsurface layer is brown sand about 7 inches thick. The subsoil is multicolored, very friable sand about 41 inches thick. The underlying material is brown sand. Between depths of 60 to 120 inches or more, there are bands and layers of reddish brown loam, sandy loam, loamy fine sand, and silty clay. In places the dark reddish brown layer in the upper part of the subsoil is very thin or absent.

Included with this soil in mapping are small areas of less permeable Emmet, Manistee, and Montcalm soils. These soils are on knolls and foot slopes. The included soils make up 15 to 20 percent of the unit.

Permeability is rapid, available water capacity is low, and surface runoff is slow.

Most areas of this soil are woodland. This soil is well suited to woodland. Common native trees are sugar maple, American beech, yellow birch, northern red oak, white ash, black cherry, and eastern white pine. Deep-rooted tree species, such as northern red oak, grow especially well on this soil. Seedling mortality and equipment limitations caused by sandiness are the major management concerns. Planting containerized seedlings in well prepared sites reduces seedling mortality. The sandy surface layer limits the trafficability of equipment during dry periods.

This soil is generally not suited to cultivated crops and is poorly suited to pasture. It generally is not used for these purposes.

This soil is fairly well suited as sites for buildings. It has poor filtering capacity for septic tank absorption fields. Slope is an additional limitation. Buildings constructed on this soil should be designed to conform to the natural slope of the land. Installing distribution lines for septic tank absorption fields across the slope is generally necessary for proper operation. Land shaping may be necessary in some areas. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability classification is VIs. The Michigan soil management group is 5a.

36E—Kalkaska sand, banded substratum, 12 to 40 percent slopes. This rolling to very steep, well drained soil is on ridges and hills. Individual areas are irregular in shape and range from about 100 acres to 500 acres.

Typically, the surface layer is very dark grayish brown sand about 2 inches thick. The subsurface layer is brown sand about 7 inches thick. The subsoil is multicolored, very friable sand about 41 inches thick. The underlying material is brown sand. At a depth of 60 to 120 inches or more, there are bands and layers of reddish brown loam, sandy loam, loamy fine sand, and silty clay. In places the dark reddish brown layer in the upper part of the subsoil is very thin or absent.

Included with this soil in mapping are small areas of less permeable Emmet and Montcalm soils. These soils are on ridges and hills. The included soils make up 10 to 15 percent of the unit.

Permeability is rapid, available water capacity is low, and surface runoff is slow.

Areas of this soil are almost entirely woodland. The soil is well suited to woodland. Common native trees are sugar maple, American beech, yellow birch, northern red oak, white ash, black cherry, and eastern white pine. Deep-rooted tree species, such as northern red oak, grow especially well on this soil. Management concerns are the hazard of erosion, equipment limitations, and seedling mortality. Roads, skid trails, and landings should be located on gentle grades to overcome equipment limitations, and water should be removed with water bars, culverts, and drop structures to control erosion. The use of ordinary crawler tractors or rubber-tired skidders is limited on steep slopes. Special operations, such as yarding logs uphill with cable, may be needed. Planting containerized seedlings in well prepared sites reduces seedling mortality. Hand planting may be necessary on the steeper slopes.

This soil is not suited to farming because of steepness and droughtiness. Crops and pastures are not grown.

This soil is poorly suited as sites for buildings on the lower slopes and is not suitable for this use on the steeper slopes. Slope is the limitation. Poor filtering capacity for septic tank absorption fields is an additional limitation. Buildings that are constructed on the lower slopes of this soil should be designed to conform to the natural slope. Installing distribution lines for septic tank absorption fields across the slope is generally needed for proper function. Land shaping is necessary in many areas. This soil readily absorbs the effluent from septic tank absorption fields, but it does not adequately filter the effluent. The poor filtering capacity can result in the pollution of ground water supplies.

The land capability subclass is VIIs. The Michigan soil management group is 5a.

37—Fluvaquents and Histosols. This map unit consists of nearly level, poorly drained and very poorly drained soils on the flood plains of river valleys and their tributaries. These soils are frequently flooded. Individual areas are elongated and irregular in shape. They range from about 10 acres to 600 acres. The Fluvaquents make up 50 to 60 percent of this map unit, and the Histosols make up 40 to 50 percent. The short, steep

side slopes adjacent to some of the narrow drainageways are included in this unit.

These soils vary widely from place to place. Texture of the mineral soils ranges from sand to silty clay. The mineral soils and the muck soils generally are intricately mixed, but some areas are either dominantly mineral soils or dominantly muck soils.

These soils vary greatly in some important properties, especially permeability and water capacity. Surface runoff is very slow. The high water table is near or above the surface during much of the year.

These soils are entirely in woodland. Common native trees are northern white-cedar, black spruce, red maple, balsam fir, black ash, and quaking aspen. These soils are poorly suited to woodland. Wetness, frequent flooding, and unstable material hinder logging operations. Accessibility is an additional problem. Seedling mortality and windthrow are severe problems. Expected loss of seedlings generally is more than 50 percent, and seedlings are generally not replanted. Trees frequently blow over during windstorms, especially on the muck soils.

Limitations are severe for most other land uses. Onsite investigation is needed to determine the suitability of these soils for development.

Prime Farmland

Prime farmland is one of several kinds of important farmlands defined by the U.S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The supply of high quality farmland is limited. The U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, must encourage and facilitate the use of our nation's prime farmland with wisdom and foresight.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. It has the soil quality, growing season, and moisture supply needed to economically produce a sustained high yield of crops when it is treated and managed using acceptable farming methods. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland may now be in crops, pasture, woodland, or other land; but not urban and built-up land or water areas. It must either be used for producing food or fiber or be available for these uses.

Prime farmland usually has an adequate and dependable supply of moisture from precipitation or irrigation. It also has a favorable temperature and growing season, and acceptable acidity or alkalinity. It has few or no rocks and is permeable to water and air. Prime farmland is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. For more detailed information on the criteria for prime farmland, consult the local staff of the Soil Conservation Service.

A recent trend in land use in some parts of the country has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal land, which generally is more erodible, droughty, difficult to cultivate, and usually less productive.

The following map units, or soils, make up the prime farmland in Lake and Wexford Counties. The list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps in the back of this publication. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units."

Soils that have limitations—a high water table, flooding, or inadequate rainfall—may qualify as prime farmland if these limitations are overcome by such measures as drainage, flood control, or irrigation. In the following list, the measures used to overcome the limitations, if any, are shown in parentheses after the map unit name. Onsite evaluation is necessary to see if these limitations have been overcome by corrective measures.

12B Emmet-Montcalm complex, 0 to 6 percent slopes
16B Hodenpyl-Karlin complex, 0 to 4 percent slopes
17A Kawkawlin loam, 0 to 4 percent slopes (where drained)
21B Nester sandy loam, 1 to 6 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties (*8*).

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where wetness or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Dwight Quisenberry, agronomist, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

According to the 1978 U.S. Census of Agriculture (*8*), about 31,504 acres in Lake and Wexford Counties was used for crops and pasture. Of this, 8,789 acres was used for permanent pasture; 3,546 acres was in row crops, mainly corn; 2,241 acres was in close-growing crops, mainly wheat and oats; and 15,985 acres was in grasses and legumes for hay. About 943 acres was used for specialty crops, mainly small fruits and vegetables.

Soil erosion, including soil blowing, is a major hazard on most areas of the cropland. Erosion is damaging for several reasons. Topsoil lost by erosion is generally the most fertile part of the soil. Erosion can damage plants, which reduces yields. Sediment from erosion pollutes streams and lakes.

Soil blowing is a major hazard on about 70 percent of the cropland. The sandy soils are most susceptible to soil blowing, but the loamy soils also are subject to serious damage if they are unprotected. Soil blowing is a major hazard on the Emmet, Hodenpyl, Kalkaska, Karlin, Manistee, and Montcalm soils.

Water erosion is a major hazard on about 40 percent of the cropland. The soils subject to serious water erosion are the Dighton, Nester, Emmet, Manistee, and Montcalm soils.

Erosion control provides protective cover, reduces runoff, and increases water infiltration. The regular application of barnyard manure and green manure crops to the soil helps maintain stable soil structure in the surface layer, improves soil tilth, and increases infiltration of water. Strips of row crops can be alternated with strips of hay. They can be planted across prevailing winds and on the contour of gentle slopes. Contouring is impractical on the short, irregular slopes of Emmet and Montcalm soils. Tillage systems that keep vegetative cover on the surface during the periods of greatest erosion can hold soil losses to an amount that does not reduce productivity. Surface residue also helps to retain soil moisture. Grassed waterways, especially in areas of Dighton and Nester soils, prevent gullying. In areas used

as permanent pasture, proper stocking and timely deferment of grazing during dry periods prevent overgrazing that exposes the soil to erosion. Deferring grazing when the fine textured Dighton and Nester soils are wet prevents compacting. Compaction increases runoff, and the soil becomes more susceptible to erosion.

Drainage is a major management need on about 24 percent of the soils used for cropland and pasture. The removal of excess water in the root zone is necessary for a proper air-water relationship. Tillage and seed germination are also adversely affected by excess water in the soil. Among the somewhat poorly drained soils, the Allendale and Kawkawlin soils are most commonly used for crops. Unless these soils are adequately drained, crops are damaged in most years because of wetness. Some cleared areas of Au Gres and Finch soils are used for permanent pasture. Artificial drainage is needed on these soils for many of the most favored forage plants.

Nester and Dighton soils have good natural drainage most of the year. They tend to dry slowly after becoming wet, especially on slopes of less than 6 percent. Small depressions within areas of Nester and Manistee soils remain wet through much of the year. These soils are more easily managed and more productive if the depressions are artificially drained.

A combination of subsurface drainage and ditches is the common method of draining excess water from the soil. Drains need to be more closely spaced in slowly permeable soils, such as the Nester and Dighton soils, and more widely spaced in more permeable soils, such as the Emmet and Montcalm soils.

In a few areas, soils have been artificially drained for good crop production. A major problem is the general lack of suitable drainage outlets. In many places, however, adjacent landowners can cooperatively install ditches that drain excess water into a natural drainage system. In some areas artificial drainage is impractical because the soils are in the lowest position of the landscape. In addition, low lying soils frequently have a shortened growing season because frost extends late into the spring and comes early in the fall.

Soil tilth is a serious management problem on about 18 percent of the cropland. Tilth affects tillage practices, seed germination, and infiltration of water. Soils with good tilth are porous, friable, and granular. They are easily tilled. Good tilth is difficult to maintain on clayey soils, such as Dighton, Kawkawlin, and Nester soils. Working these soils when they are wet can break down soil structure and cause compaction and puddling. Grazing livestock when the soils are wet can cause compaction. These soils tend to become hard and cloddy when dry, and good seedbeds are difficult to establish. Good management practices are tilling the soil at the proper moisture content and maintaining a high level of organic matter in the soil. Organic matter can be maintained by growing green manure crops and by regularly applying barnyard manure to the soil.

Soil fertility is naturally low in most sandy soils and medium to high in loamy soils. Sandy soils on uplands, such as Kalkaska and Montcalm soils, are naturally low in content of available nitrogen, phosphorus, and potash. They are naturally medium acid to strongly acid. Periodic applications of ground limestone are needed to raise the pH level to nearly neutral for good crop production. Loamy soils, such as Emmet, Hodenpyl, and Nester soils, have medium to high natural fertility. They are generally less acid than the sandy soils. Applications of lime and fertilizer to all soils should be based on the results of soil tests, crop requirements, and the expected level of the crop yields. The Cooperative Extension Service can assist in determining the kind and amount of fertilizer and lime to apply (*6*).

Field crops suited to the soils and climate of the survey area include several crops that are not commonly grown. Corn is by far the most commonly grown row crop in the area. Potatoes, field beans, and similar crops can be grown if economic conditions are favorable. Wheat, oats, and alfalfa and bromegrass for hay are common close-growing crops. Barley, rye, buckwheat, red and Ladino clover, and timothy are other crops suited to the survey area.

Only a small acreage of specialty crops is grown commercially in the survey area. These crops include strawberries, cucumbers, snap beans, and sunflowers. Droughtiness severely limits expanding the acreage of specialty crops grown in Lake and Wexford Counties. The development of irrigation systems in the area, however, would permit growing many specialty crops in addition to those now being grown. Such crops could include raspberries, blueberries, grapes, asparagus, sweet corn, peppers, and squash. Information and suggestions for growing specialty crops can be obtained from the Cooperative Extension Service and the Soil Conservation Service.

Much of the permanent pasture in the county is on soils where erosion can be a hazard. Control of erosion is particularly important during seeding operations. Other pastures are areas of wet soils. The need for lime and fertilizer should be determined by soil tests.

Soil compaction caused by grazing when the soils are wet results in decreased growth of pasture grasses. Proper harvesting methods, such as those used for hay or silage, help to increase plant growth and reduce soil compaction.

The productivity of a pasture and its ability to protect the surface of the soil are influenced by the number of livestock it supports, the length of the grazing period, and rainfall distribution. Good pasture management includes the use of stocking rates that maintain key forage species, pasture rotation, deferred grazing, grazing at the proper season, and supplying water at strategic locations for the livestock.

Yields Per Acre

The average yields per acre that can be expected of the principal crops and pasture under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The capability classification is also shown for each unit.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops (*10*). Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils does not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed Soil Map Units." Also given at the end of each description is a Michigan soil management group. The soils are assigned to a group according to the need for lime and fertilizer and for artificial drainage and other practices. For soils making up a complex, the management groups are listed in the same order as the series named in the complex. For a detailed explanation of the Michigan soil management groups, see Michigan State University Bulletin E-1267 (*5*).

Woodland Management and Productivity

David J. Poe, forester, Soil Conservation Service, assisted in the preparation of this section.

The use and management of woodlands is discussed in this section. This section describes the major kinds of forest cover and the relationship of kinds of cover to kinds of soils and lists present and potential woodland products. The woodland suitability group of soils and the growth and management problems associated with specific soils are also discussed.

All of Lake and Wexford Counties originally was covered with virgin forests of pine and hardwoods. The entire area was harvested, and the slash burned. Many areas were cleared. The present woodland is a second-growth timber. Much cleared land has been replanted to pines. Although the present woodland stands do not approach the original virgin timber stands in size or value, the woodland is certainly an important and valuable resource in this area.

At present, about 520,000 acres of woodland or 72 percent of the survey area is in Lake and Wexford Counties. About 303,000 acres is in national or state forest. Several private companies have large holdings of woodland, but most of the 217,000 acres of privately owned woodland is in small, individually owned units.

Forest Cover

Five major kinds of natural forest cover are within the survey area. Each is distinctly different. Each has different value and potential for use as forest and for woodland products. The kinds of soils also are generally quite different for each of the different kinds of forest cover.

Jack Pine-Oak Forest Cover—This cover grows on about 125,000 areas. Jack pine, northern red oak, pin oak, and white oak dominate. Other common associated tree species are eastern white pine, red pine, and bigtooth aspen. This cover type grows on Graycalm and Grayling soils. These deep, sandy soils have a weak profile development. The Graycalm soil has thin bands of loamy sand in the lower part of the subsoil. The more droughty and less fertile Grayling soil supports only scrubby stands of oak and jack pine. On Grayling soil, growth rates are slow. It is difficult to reestablish tree cover in cutover areas of Grayling soil. The Graycalm soil supports more vigorous oaks, as well as other associated species. On Graycalm soil, growth rates are fair. Young red pine and jack pine plantations are common in areas of Graycalm soil.

Oak-Red Maple Forest Cover—This cover type grows on about 190,000 acres. Northern red oak, white oak, and red maple dominate. Other associated tree species include bigtooth aspen, red pine, eastern white pine, and paper birch. The virgin forest cover was mostly eastern white pine, but it was almost completely removed by logging. Today, white pine makes up only a small part of the forest cover. Red maple distinguishes this forest cover from transitional areas of the Jack Pine-Oak forest cover. The Oak-Red Maple forest cover grows on Rubicon, Montcalm, and Graycalm soils. These are deep, sandy soils. The Montcalm and Graycalm soils have bands of loam or loamy sand in the subsoil. Growth rates are good in these soils. Young plantations of red pine and eastern white pine are common within areas of this cover type. Christmas tree plantations, mostly of Scotch pine, are also common.

Sugar Maple-Beech-Yellow Birch Forest Cover.—This cover type grows on about 100,000 acres. Sugar maple is the most common tree species and is almost always dominant. American beech, yellow birch, and red maple are very common. Other common associated tree species are black cherry, northern red oak, and quaking aspen. The amount of American basswood, eastern hemlock, eastern white pine, red pine, white oak, bigtooth aspen, and white ash varies. The virgin forest in this cover type was northern hardwoods. The soils include Dighton, East Lake, Emmet, Hodenpyl, Kalkaska, Karlin, Mancelona, Manistee, Montcalm, and Nester soils. These loamy soils and more fertile sandy soils are the most productive in the survey area. Growth rates are good or excellent. Potential for woodland products is high. Christmas tree plantations are common within areas of this cover type.

Red Maple-Paper Birch-White Spruce-Balsam Fir Forest Cover.—This cover type grows on about 35,000 acres. Most stands are a mixture of wetland hardwoods and conifers and include a wide range of tree species. Red maple, paper birch, white spruce, balsam fir, quaking aspen, and eastern hemlock dominate. Other common associated species are eastern white pine, northern white-cedar, black ash, and balsam poplar. The amount of sugar maple, northern red oak, and white oak varies. American elm was an important component of this cover type; however, almost all elm trees have died as a result of Dutch Elm disease. In many areas, much of this dead wood has been removed for firewood.

The soils have a seasonal high water table. They include Allendale, Au Gres, Croswell, Finch, Kawkawlin, and Winterfield soils. Both sandy and loamy soils support this cover type. The rate of growth for trees is fair to good.

Northern White-Cedar Forest Cover.—This cover type grows on about 70,000 acres. Northern white-cedar dominates, but other commonly associated species are black spruce, black ash, red maple, eastern hemlock, balsam fir, balsam poplar, and tamarack. This cover type grows on Lupton, Roscommon, Tawas, and Fluvaquents and Histosols soils. These poorly drained and very poorly drained soils are organic and mineral. The water table is near or above the surface most of the time. Trees grow slowly. Reestablishing stands of desirable species in cutover areas is difficult. Windthrow is a serious problem in areas cleared by cutting.

Woodland Products

Although a large part of Lake and Wexford Counties is in woodland, the amount of woodland products harvested each year is relatively low. The potential exists for continuous high production of woodland products in this area. Better woodland management is needed, particularly on privately owned land, if this potential is to be realized. Some of the more important woodland products are as follows.

Christmas trees.—This woodland product has achieved much of its potential. Growing and marketing Christmas trees is an important industry in the survey area (fig. 14). Most of the Christmas trees are grown in Wexford County. Trees are shipped from this area each fall to many parts of the United States. About 80 percent of the Christmas trees grown in this area is Scotch pine. Spruce makes up most of the rest. Scotch pines usually are harvested at an age of 6 to 8 years. Spruce are harvested at an age of 8 to 12 years. Most Christmas trees are grown on deep sandy soils, including the Kalkaska, Kalkaska-East Lake, Montcalm-Graycalm, Manistee, Rubicon, Hodenpyl-Karlin, and Croswell soils.

Pulpwood.—Most of the pulpwood is taken from cuttings of small tracts in state and national forest land or from land owned by paper companies. Aspen and jack pines are the most common trees cut for pulp. Some spruce, balsam fir, and hemlock are also cut for pulp. This area has potential for producing a large amount of pulpwood. One reason that little pulpwood is taken from small, privately owned woodland tracts is that, individually, each tract is too small to justify logging operations. More pulpwood could be harvested if the owners of several adjacent tracts would combine their logging operations. Pulpwood is harvested from most of the soils in the survey area.

Lumber.—Only a small amount of lumber is produced in the survey area at present. The trees in most of the wooded areas are relatively small. They are mostly pole or sapling size. Most of the large, high-quality trees have been removed, and the remaining larger trees are usually of poor quality for lumber. Only an occasional area has many high-quality trees of sawlog size. If good woodland management practices are used, the potential for future production of sawlog timber for lumber is good. Good management includes thinning pine plantations and culling and thinning northern hardwood stands. Tree species most often cut for lumber are northern red oak, sugar maple, and red pine.

Firewood.—Firewood is becoming increasingly more important as a renewable source of heat and energy as fossil fuels become more expensive. Many homes use firewood as the main source or as a supplementary source of heat. Oak and maple trees are most commonly used for firewood; however, most trees have some value as fuel.

Poles and posts.—The numerous red and jack pine plantations provide a good potential source of treated poles and posts. Northern white-cedar, which grows in many of the wet areas, is used for posts.

Figure 14.—Christmas trees assembled for shipment to market. About 800,000 Christmas trees are harvested each year.

Maple syrup.—Northern hardwood stands that contain mature maple trees are a good potential source for maple sugar.

Woodland recreation.—Because of the large amount of woodland in the survey area, and particularly the large amount of public lands, year-round woodland recreation is very important. This woodland use is discussed in more detail in the recreation section of this report.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high

productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that few trees may be blown down by strong winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Recreation

Lake and Wexford Counties provide excellent year-round, outdoor recreation. They have more than a half-million acres of woodland, and nearly 60 percent of the woodland is in national and state forests. Many trails in the Manistee National Forest and the Fife Lake and Pere Marquette State Forests are maintained for hiking and for off-road vehicles in the summer and for cross-country skiing and snowmobiling in the winter. Several of the larger and steeper hills are sites for alpine skiing (fig. 15). Many inland lakes are used for boating, fishing, and swimming. Three rivers in the survey area, the Manistee, Pine, and Pere Marquette Rivers, provide excellent canoe trails. Deer, ruffed grouse, and turkey provide good hunting in the fall. Enjoying the natural scenery of the area is an additional important form of recreation. Although many people enjoy the outdoor recreation the survey area affords, there is considerable undeveloped potential for recreation.

Figure 15.—Alpine skiing is a popular winter sport in developed areas of Kalkaska sand, 12 to 40 percent slopes.

The kind of soil is important in determining the recreation facilities to be developed. Many soils have severe limitations for camp areas, picnic areas, playgrounds, or paths and trails for hiking or riding. Other soils are well suited to such uses.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example,

interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry.

Paths and trails for hiking and horseback riding, should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, water, and living space. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, and oats.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are ragweed, goldenrod, lambsquarters, wild carrot, dandelion, burdock, and wild strawberry.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for

planting on soils rated *good* are silky dogwood, gray dogwood, honeysuckle, American cranberry bush, autumn-olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cattail, rushes, sedges, reeds, and arrowhead.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, tree squirrels, red fox, raccoon, deer, and bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The

limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, and the available water capacity in the upper 40 inches affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, and flooding affect absorption of the effluent. Large stones interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is

required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction.

Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, and rock fragments.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or stones, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or of organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. The content of large stones affects the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and

the stability of ditchbanks are affected by large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones. The performance of a system is affected by the depth of the root zone and soil reaction.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, and slope affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The

estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops.

They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission. Some soils are assigned to two hydrologic groups because part of the acreage is drained and part is undrained.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than

that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Characterization Data for Selected Soils

Many of the soils in the Lake and Wexford survey area were sampled by the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan. The laboratory data obtained from the soil samples include particle size distribution analysis, coarse fragment analysis, bulk density, and moisture retention data. In addition, complete chemical analyses were performed on each sample, and spodic horizon criteria determined on the appropriate samples. Standard National Cooperative Soil Survey procedures were used for all analyses. In addition to soil samples, forest sites were sampled to estimate forest productivity on many of the sampled soils.

These data were used in the classification and correlation of the soils in evaluating their behavior, especially under forestry uses. Nine profiles were selected as representative for the respective series. These series and their laboratory identification number are: Graycalm (579MI085-1), Grayling (S79MI085-2), Hodenpyl (S79MI165-1), Kalkaska (S78MI165-1, S79MI165-2), Montcalm (S78MI085-1, S78MI085-2, S79MI165-3), and Rubicon (S78MI165-2).

In addition to the Lake and Wexford survey data, soil characterization data and forest site data are available from nearby counties that have many of the same soils that were not sampled in Lake and Wexford Counties. These data and the Lake and Wexford County data are available from the Soil Research Laboratory, Ford Forestry Center, Michigan Technological University, L'Anse, Michigan; The Soil and Water Conservation Division, Michigan Department of Agriculture, Lansing, Michigan; and The Soil Conservation Service, State Office, East Lansing, Michigan.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*11*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Psamment (*Psamm*, meaning sandy texture, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Udipsamments (*Ud*, meaning humid, plus *psamment*, the suborder of the Entisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Udipsamments.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is mixed, frigid Typic Udipsamments.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*9*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*11*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Allendale Series

The Allendale series consists of somewhat poorly drained soils. These soils formed in sandy deposits and in the underlying loamy and clayey materials on low flats and in drainageways of till plains. They are rapidly permeable in the upper part and slowly permeable in the lower part. Slope ranges from 0 to 4 percent.

Allendale soils are commonly adjacent to Au Gres, Kawkawlin, and Manistee soils in the landscape. Au Gres soils are sandy throughout the pedon. Kawkawlin soils are loamy throughout the solum. Manistee soils are well

drained. The Au Gres, Kawkawlin, and Manistee soils are on low flats and in drainageways of till plains.

A typical pedon of Allendale loamy sand, 0 to 4 percent slopes, 1,300 feet west and 500 feet south of the northeast corner of sec. 5, T. 23 N., R. 10 W., in Wexford County:

A—0 to 4 inches; black (10YR 2/1) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; many fine roots; medium acid; abrupt smooth boundary.

Bs—4 to 23 inches; brown (7.5YR 4/4) loamy sand; fine common distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; many fine roots; medium acid; clear wavy boundary.

E—23 to 27 inches; brown (10YR 5/3) loamy sand; common medium faint yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; very friable; few fine roots; slightly acid; diffused wavy boundary.

2B/E—27 to 37 inches; reddish brown (5YR 4/3) clay loam (Bt); moderate medium subangular blocky structure; firm; interfingering between peds, brown (10YR 5/3) loam (E); common fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; few fine roots; slightly acid; diffused wavy boundary.

2Bt—37 to 43 inches; reddish brown (5YR 4/3) clay; common fine distinct yellowish brown (10YR 5/6) mottles; strong fine angular blocky structure; very firm; thin continuous clay films on ped faces; few fine roots; neutral; gradual wavy boundary.

2C—43 to 60 inches; reddish brown (5YR 4/3) clay; common fine distinct yellowish brown (10YR 5/6) and common medium prominent olive gray (5YR 5/2) mottles; moderate medium angular blocky structure; very firm; moderately alkaline; slightly effervescent.

Depth to the 2B/E horizon ranges from 20 to 40 inches. The solum ranges from strongly acid to slightly acid in the sandy upper part and is neutral in the lower part. Pebble content is dominantly less than 5 percent throughout the solum.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly loamy sand but the range includes loamy fine sand and sand. The Bs horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 or 4. It is loamy sand, loamy fine sand, or sand. The E horizon has value of 5 or 6 and chroma of 2 or 3. It is loamy sand, loamy fine sand, sandy loam, or loam. The Bt material has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 3 or 4. It is clay loam, silty clay loam, or silty clay in the 2B/E horizon and clay or silty clay in the 2Bt horizon. The 2C horizon has value of 4 or 5 and chroma of 2 to 4. It is clay or silty clay. The 2C horizon is neutral to moderately alkaline.

Au Gres Series

The Au Gres series consists of somewhat poorly drained, rapidly permeable soils. These soils formed in sandy deposits on low flats and benches of outwash plains and moraines. Slope ranges from 0 to 4 percent.

Au Gres soils are similar to Finch soils and are commonly adjacent to Croswell, Graycalm, Roscommon, Rubicon, and Tawas soils. Finch soils have an ortstein layer in the Bs horizon. Croswell soils are moderately well drained; Graycalm and Rubicon soils are somewhat excessively drained; Roscommon and Tawas soils are very poorly drained. Croswell soils are on low flats and benches of outwash plains and moraines. Graycalm and Rubicon soils are slightly higher in the landscape than Au Gres soils, and Roscommon and Tawas soils are in depressional areas.

A typical pedon of Au Gres sand in an area of Au Gres-Finch sands, 0 to 4 percent slopes, 2,240 feet north and 610 feet east of the southwest corner of sec. 32, T. 22 N., R. 10 W., in Wexford County:

A—0 to 2 inches; very dark gray (10YR 3/1) sand, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; many fine and medium roots; strongly acid; abrupt smooth boundary.

E—2 to 11 inches; light brownish gray (10YR 6/2) sand; few fine faint brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; very friable; many fine and medium roots; strongly acid; abrupt wavy boundary.

Bhs—11 to 13 inches; dark reddish brown (5YR 3/4) sand; few medium faint brown (7.5YR 5/4) mottles; moderate medium subangular blocky structure; very friable; common fine roots; strongly acid; clear wavy boundary.

Bs1—13 to 19 inches; reddish brown (5YR 4/4) sand; many coarse distinct strong brown (7.5YR 5/6) and brown (7.5YR 5/4) mottles; weak medium subangular blocky structure; very friable; common fine roots; medium acid; clear wavy boundary.

Bs2—19 to 24 inches; strong brown (7.5YR 5/6) sand; common medium distinct yellowish red (5YR 4/6) and yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; very friable; few fine roots; medium acid; gradual wavy boundary.

BC—24 to 38 inches; yellowish brown (10YR 5/4) sand; common coarse distinct yellowish red (5YR 5/6) mottles; single grain; loose; few fine roots; medium acid; gradual wavy boundary.

C—38 to 60 inches; light yellowish brown (10YR 6/4) sand; common fine faint brownish yellow (10YR 6/6) mottles; single grain; loose; few fine roots; medium acid.

The solum ranges from 20 to 40 inches in thickness. Reaction ranges from strongly acid to neutral. Pebble and cobble content ranges from 0 to 5 percent.

The A horizon has chroma of 1 or 2. It is dominantly sand, but the range includes loamy sand. The E horizon has hue of 7.5YR or 10YR and value of 5 or 6. It is dominantly sand but includes loamy sand. The Bs horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. The C horizon has value of 4 or 5 and chroma of 3 or 4.

Croswell Series

The Croswell series consists of moderately well drained, rapidly permeable soils. These soils formed in sandy deposits on low flats and benches of outwash plains. Slope ranges from 0 to 4 percent.

Croswell soils are similar to Rubicon soils and are commonly adjacent to Au Gres, Graycalm, and Grayling soils. Au Gres soils are somewhat poorly drained; Graycalm and Rubicon soils are somewhat excessively drained; and Grayling soils are excessively drained. Au Gres soils are in slightly lower swales. Graycalm and Grayling soils are on higher positions in the landscape.

A typical pedon of Croswell sand, 0 to 4 percent slopes, 2,480 feet south and 450 feet east of the southwest corner of sec. 32, T. 22 N., R. 10 W., in Wexford County:

A—0 to 2 inches; very dark gray (10YR 3/1) sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; very strongly acid; abrupt smooth boundary.

E—2 to 15 inches; grayish brown (10YR 5/2) sand; weak fine subangular blocky structure; very friable; many fine and medium roots; very strongly acid; abrupt wavy boundary.

Bhs—15 to 18 inches; dark brown (7.5YR 3/4) sand; weak medium subangular blocky structure; very friable; common fine roots; very strongly acid; clear wavy boundary.

Bs1—18 to 22 inches; dark brown (7.5YR 4/4) sand; fine faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; common fine roots; very strongly acid; gradual wavy boundary.

Bs2—22 to 27 inches; strong brown (7.5YR 4/6) sand; common medium distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; very friable; common fine roots; very strongly acid; gradual wavy boundary.

BC—27 to 38 inches; dark yellowish brown (10YR 4/6) sand; common coarse distinct yellowish brown (10YR 5/8) mottles; massive; slightly firm; common fine roots; very strongly acid; clear smooth boundary.

C—38 to 60 inches; brown (10YR 5/3) sand; common medium distinct yellowish brown (10YR 5/6) and pale brown (10YR 6/3) mottles; single grain; loose; few fine roots; medium acid.

The solum ranges from 2 to 40 inches in thickness. Reaction ranges from very strongly acid to slightly acid. Pebble and cobble content ranges from 0 to 5 percent.

The A horizon has chroma of 1 or 2. It is dominantly sand, but the range includes loamy sand. The E horizon has hue of 7.5YR or 10YR and value of 5 or 6. It is dominantly sand but includes loamy sand. The Bs horizon has hue of 5YR, 7.5YR, or 10YR; value of 3 to 5; and chroma of 3 to 6. The C horizon has value of 5 or 6 and chroma of 3 to 6.

Dighton Series

The Dighton series consists of well drained soils. These soils formed in loamy materials over sandy sediment on till plains and moraines. Permeability is moderately slow in the upper part and rapid in the lower part. Slope ranges from 6 to 12 percent.

Dighton soils are similar to Nester soils and are commonly adjacent to Allendale, Emmet, Kalkaska, Manistee, and Montcalm soils. Nester soils do not have sandy underlying material. Allendale and Manistee soils are sandy in the upper part and clayey and loamy in the lower part. Emmet soils are dominantly loamy throughout the pedon. Kalkaska and Montcalm soils are dominantly sandy soils. Allendale, Emmet, and Manistee soils are on till plains and moraines, and Kalkaska and Montcalm soils on the tops of ridges and knolls.

A typical pedon of Dighton loam, 6 to 12 percent slopes, 1,650 feet south and 50 feet east of the northwest corner of sec. 21, T. 21 N., R. 10 W., in Wexford County:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; moderate fine subangular blocky structure; friable; common fine roots; slightly acid; abrupt smooth boundary.

B/E—8 to 15 inches; brown (10YR 4/3) clay loam (Bt); moderate fine subangular blocky structure; firm; interfingering between peds, pale brown (10YR 6/3) loam (E); massive; friable; common fine roots; slightly acid; clear wavy boundary.

Bt1—15 to 22 inches; reddish brown (5YR 4/3) clay loam; strong fine angular blocky structure; thin nearly continuous clay films on ped faces; very firm; few fine roots; strongly acid; clear wavy boundary.

Bt2—22 to 31 inches; brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; strongly acid; diffused wavy boundary.

2C1—31 to 36 inches; brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; firm; strongly acid; diffused wavy boundary.

2C2—36 to 60 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; slightly acid.

The solum ranges from 20 to 40 inches thick. Reaction ranges from strongly acid to slightly acid. Pebble content ranges from 0 to 2 percent.

The Ap horizon has chroma of 2 or 3. It is dominantly loam, but the range includes clay loam. The B part of the B/E horizon has hue of 5YR, 7.5YR, or 10YR and value and chroma of 3 or 4. The E part has value of 5 or 6 and chroma of 2 or 3. It is loam or clay loam. The Bt horizon has hue of 5YR, 7.5YR, or 10YR and value and chroma of 3 or 4. The 2C2 horizon has value and chroma of 4 to 6. It is sand, loamy sand, or gravelly sand.

East Lake Series

The East Lake series consists of somewhat excessively drained, very rapidly permeable soils. These soils formed in sandy deposits on outwash plains, kames, and moraines. Slope ranges from 0 to 30 percent.

East Lake soils are similar to Kalkaska and Mancelona soils and are commonly adjacent to Graycalm, Kalkaska, Karlin, Mancelona, and Montcalm soils. Kalkaska soils do not have the 2C horizon of gravelly sand. Graycalm soils do not have a spodic horizon and have thin argillic bands. Karlin soils are loamy sand over sand. Mancelona and Montcalm soils have an argillic horizon. Graycalm, Karlin, and Montcalm soils are on outwash plains, kames, and moraines.

A typical pedon of East Lake sand in an area of Kalkaska-East Lake sands, 0 to 6 percent slopes, 2,080 feet west and 750 feet north of the southeast corner of sec. 34, T. 25 N., R. 12 W., in Wexford County:

A—0 to 4 inches; very dark grayish brown (10YR 3/2) sand, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; 2 percent pebbles; neutral; abrupt smooth boundary.

Bs1—4 to 9 inches; brown (7.5YR 4/4) sand; weak fine subangular blocky structure; very friable; common fine roots; 5 percent pebbles; neutral; gradual wavy boundary.

Bs2—9 to 21 inches; yellowish brown (10YR 5/4) sand; weak medium subangular blocky structure; very friable; common fine roots; 5 percent pebbles; neutral; clear irregular boundary.

2C1—21 to 33 inches; dark yellowish brown (10YR 4/4) gravelly sand; single grain; loose; 40 percent pebbles; strong effervescence; moderately alkaline; gradual wavy boundary.

2C2—33 to 60 inches; yellowish brown (10YR 5/4) very gravelly sand; single grain; loose; 60 percent pebbles; strong effervescence; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness. It is medium acid to neutral. Pebble content ranges from 1 to 15 percent in the solum.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bs horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 or 6. The BC horizon is present in some pedons. The 2C horizon has value of 4 to 6 and chroma of 3 or 4. It is gravelly sand, very gravelly sand, or sand. Reaction in the 2C horizon is mildly alkaline to strongly alkaline.

Emmet Series

The Emmet series consists of well drained, moderately permeable soils. These soils formed in loamy material over sandy deposits on moraines and till plains. Slope ranges from 0 to 40 percent.

Emmet soils are commonly adjacent to Allendale, Graycalm, Nester, Manistee, and Montcalm soils. Allendale and Manistee soils have dominantly clayey underlying material. Graycalm and Montcalm soils are sandy and have argillic bands in the subsoil. Nester soils are loamy and clayey in the lower part of the pedon. The Allendale soils are on low flats and in depressions. The Graycalm, Nester, Manistee, and Montcalm soils are on moraines and till plains.

A typical pedon of Emmet sandy loam in an area of Emmet-Montcalm complex, 12 to 18 percent slopes, 400 feet south and 100 feet west of the northeast corner of sec. 25, T. 21 N., R. 9 W., in Wexford County:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) sandy loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure parting to moderate medium granular; very friable; many fine roots; slightly acid; abrupt smooth boundary.

Bw—8 to 20 inches; brown (7.5YR 4/4) sandy loam; moderate fine subangular blocky structure; very friable; common fine roots; slightly acid; clear wavy boundary.

E—20 to 23 inches; brown (10YR 4/3) sandy loam; weak medium subangular blocky structure; very friable; common fine roots; slightly acid; clear irregular boundary.

B/E—23 to 28 inches; reddish brown (5YR 4/3) sandy loam (Bt); moderate medium subangular blocky structure; friable; brown (10YR 5/3) loamy sand (E); massive; very friable; common fine roots; neutral; gradual irregular boundary.

Bt—28 to 38 inches; reddish brown (5YR 4/3) sandy loam; moderate medium subangular blocky structure; friable; common fine roots; neutral; gradual irregular boundary.

C—38 to 60 inches; yellowish brown (10YR 5/4) loamy sand; weak medium subangular blocky structure; very friable; few fine roots; moderate effervescence; moderately alkaline.

The solum ranges from 36 to 50 inches in thickness. It is medium acid or slightly acid. Pebble and cobble content ranges from 1 to 5 percent.

The Ap horizon is dominantly sandy loam, but the range includes loamy sand. The Bw horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. It is sandy loam or loamy sand. The E horizon and the E part of the B/E horizon have hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 or 3. They are sandy loam or loamy sand. The Bt horizon and the Bt part of the B/E horizon have hue of 7.5YR or 5YR and chroma of 3 or 4. The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 or 4. It is sandy loam, loamy sand, or sand. Pebble and cobble content in the C horizon ranges from 0 to 15 percent. Reaction is moderately alkaline or strongly alkaline.

Finch Series

The Finch series consists of somewhat poorly drained soils. These soils formed in sandy deposits on low flats and terraces. Permeability is slow in the ortstein layer and rapid in the rest of the pedon. Slope ranges from 0 to 4 percent.

Finch soils are similar to Au Gres soils and are commonly adjacent to Croswell, Graycalm, Roscommon, Rubicon, and Tawas soils. Au Gres soils do not have ortstein in the Bs horizon. Croswell soils are moderately well drained; Graycalm and Rubicon soils are somewhat excessively drained; Roscommon and Tawas soils are very poorly drained. The Croswell soils are in slightly higher positions than the Finch soil. The Roscommon and Tawas soils are in depressional areas. The Graycalm and Rubicon soils are on higher positions in the landscape.

A typical pedon of Finch sand in an area of Au Gres-Finch sands, 0 to 4 percent slopes, 1,570 feet east and 100 feet north of the southwest corner of sec. 11, T. 24 N., R. 10 W., in Wexford County:

A—0 to 4 inches; very dark gray (5YR 3/1) sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many fine and medium roots; very strongly acid; abrupt smooth boundary.

E—4 to 12 inches; brown (7.5YR 5/2) sand; weak fine granular structure; very friable; many fine and medium roots; very strongly acid; abrupt wavy boundary.

Bh—12 to 14 inches; dark reddish brown (5YR 3/3) sand; common fine faint strong brown (7.5YR 5/6) mottles; weak fine granular structure; very friable; few fine roots; very strongly acid; clear broken boundary.

Bs—14 to 20 inches; strong brown (7.5YR 5/6) sand; common medium faint strong brown (7.5YR 5/8) mottles; weak fine subangular blocky structure parting to weak fine granular; very friable; few fine roots; very strongly acid; clear wavy boundary.

Bsm—20 to 28 inches; reddish brown (5YR 4/4) and yellowish red (5YR 4/6) sand; many coarse faint strong brown (7.5YR 5/6) mottles; massive; firm; strongly cemented; strongly acid; abrupt wavy boundary.

BC—28 to 35 inches; brown (7.5YR 5/4) sand; many coarse faint strong brown (7.5YR 5/8) mottles; single grain; loose; strongly acid; gradual wavy boundary.

C1—35 to 46 inches, yellowish brown (10YR 5/6) sand; common fine faint strong brown (7.5YR 5/8) mottles; single grain; loose; medium acid; gradual wavy boundary.

C2—46 to 60 inches, light yellowish brown (10YR 6/4) sand; few fine faint reddish yellow (10YR 6/4) mottles; single grain; loose; medium acid.

The solum ranges from 20 to 40 inches in thickness. It is very strongly acid to slightly acid. Pebbles range from 0 to 5 percent.

The A horizon has hue of 5YR, 7.5YR, or 10YR; value of 2 or 3; and chroma of 1 or 2. It is dominantly sand, but the range includes loamy sand. The E horizon has hue of 7.5YR or 10YR and value of 5 or 6. It is dominantly sand but includes loamy sand. The Bh horizon has hue of 5YR or 2.5YR and chroma of 2 or 3. This horizon is cemented in some pedons. The Bs horizon has hue of 5YR or 7.5YR and chroma of 3 or 4. Cementation ranges from strong to weak. The C horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 to 6.

Graycalm Series

The Graycalm series consists of somewhat excessively drained, rapidly permeable soils. These soils formed in sandy deposits on outwash plains, till plains, and moraines. Slope ranges from 0 to 30 percent.

Graycalm soils are similar to Grayling soils and are commonly adjacent to Grayling, Kalkaska, Manistee, Montcalm, and Rubicon soils. Grayling and Rubicon soils do not have bands of loamy sand in the subsoil. Kalkaska soils have well expressed spodic horizons. Manistee and Montcalm soils have argillic horizons. All of the adjacent soils are on outwash plains, till plains, and moraines.

A typical pedon of Graycalm sand in an area of Graycalm-Grayling sands, 0 to 6 percent slopes, 2,630 feet north and 250 feet west of the southeast corner of sec. 6, T. 18 N., R. 13 W., in Lake County:

A—0 to 2 inches; black (10YR 2/1) sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak coarse granular; very friable; many fine roots; very strongly acid; abrupt smooth boundary.

Bw1—2 to 7 inches; dark brown (7.5YR 4/4) sand; weak medium subangular blocky structure; loose; common fine roots; strongly acid; gradual smooth boundary.

Bw2—7 to 17 inches; brown (7.5YR 5/4) sand; very weak fine subangular blocky structure; loose; common fine roots; strongly acid; gradual smooth boundary.

Bw3—17 to 28 inches; strong brown (7.5YR 5/6) sand; single grain; loose; few fine roots; medium acid; gradual smooth boundary.

E—28 to 48 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; few fine roots; medium acid; clear smooth boundary.

E&Bt—48 to 60 inches; light yellowish brown (10YR 6/4) sand (E) and thin bands of strong brown (7.5YR 4/6) loamy sand (Bt); bands are 1/10 to 1/2 inch thick and are 4 to 8 inches apart; single grain; loose; medium acid.

Depth to the top of the argillic bands is dominantly 36 to 48 inches but ranges from 30 to 56 inches. The solum ranges from very strongly acid to medium acid.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly sand, but the range includes loamy sand. The Bw1 horizon is dominantly sand but includes loamy sand. The E horizon and the E part of the E&Bt horizon have hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 4 or 6. The Bt part has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4 to 6. It is loamy sand or sandy loam. The argillic bands range from 1/10 of an inch to 2 inches in thickness.

Grayling Series

The Grayling series consists of excessively drained, rapidly permeable soils. These soils formed in sandy deposits on pitted outwash plains and on moraines. Slope ranges from 0 to 30 pecent.

Grayling soils are similar to Graycalm soils and are commonly adjacent to Croswell, Graycalm, and Rubicon soils. Graycalm soils have bands of loamy sand in the subsoil. Croswell soils are moderately drained. Croswell soils are in swales and on flats. The Graycalm and Rubicon soils are on pitted outwash plains and on moraines.

A typical pedon of Grayling sand, 0 to 6 percent slopes, 1,550 feet south and 250 feet west of the northeast corner of sec. 29, T. 18 N., R. 13 W., in Lake County:

A—0 to 2 inches; black (10YR 2/1) sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak medium granular; very friable; many fine roots; very strongly acid; abrupt smooth boundary.

Bw1—2 to 6 inches; dark yellowish brown (10YR 4/4) sand; very weak fine subangular blocky structure; loose; common fine roots; strongly acid; clear wavy boundary.

Bw2—6 to 16 inches; dark yellowish brown (10YR 4/6) sand; very weak fine subangular blocky structure; loose; few fine roots; strongly acid; gradual smooth boundary.

BC—16 to 26 inches; yellowish brown (10YR 5/6) sand; single grain; loose; few fine roots; medium acid; gradual smooth boundary.

C—26 to 60 inches; light yellowish brown (10YR 6/4) sand; single grain; loose; medium acid.

The solum ranges from 15 to 30 inches in thickness. Reaction ranges from very strongly acid to medium acid. Pebble content ranges from 0 to 2 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The BC horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 6 or 8. The C horizon has hue of 10YR or 7.5YR, value of 6 or 7, and chroma of 2 to 4.

Hodenpyl Series

The Hodenpyl series consists of well drained, moderately permeable soils. These soils formed in loamy and sandy deposits on outwash plains. Slope ranges from 0 to 4 percent.

Hodenpyl soils are commonly adjacent to East Lake, Kalkaska, and Karlin soils. None of the adjacent soils have an argillic horizon. East Lake and Kalkaska soils are on the higher knolls and ridges. Karlin soils are on outwash plains.

A typical pedon of Hodenpyl sandy loam in an area of Hodenpyl-Karlin complex, 0 to 4 percent slopes, 2,615 feet south and 100 feet east of the northwest corner of sec. 12, T. 24 N., R. 12 W., in Wexford County:

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) sandy loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure parting to moderate fine granular; friable; many fine roots; 1 percent pebbles; strongly acid; abrupt smooth boundary.

AE—10 to 13 inches; dark brown (10YR 3/3) fine sandy loam; moderate medium subangular blocky structure; friable; common fine roots; 1 percent pebbles; strongly acid; abrupt smooth boundary.

E—13 to 25 inches; brown (7.5YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; common fine roots; 1 percent pebbles; strongly acid; gradual wavy boundary.

Bt—25 to 41 inches; dark brown (7.5YR 4/4) sandy loam; moderate fine subangular blocky structure; friable; common fine roots; thin discontinuous clay films on vertical faces of peds; strongly acid; clear wavy boundary.

2E&Bt—41 to 60 inches; pale brown (10YR 6/3) sand (E); single grain; loose; lamellae of strong brown (7.5YR 5/6) loamy sand (Bt); weak medium subangular blocky structure; very friable; wavy and

discontinuous lamellae 1/16 to 1/2 inch thick; few fine roots; 2 percent pebbles; neutral.

Depth to the 2E&Bt horizon ranges from 30 to 45 inches. The upper part of the solum is strongly acid or medium acid. The 2E&Bt horizon is slightly acid or neutral. Pebble content is dominantly less than 1 percent in the upper part of the solum but ranges to 10 percent in the 2E&Bt horizon.

The Ap horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. It is dominantly fine sandy loam, but the range includes loam or sandy loam. The Bw horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 4. It is sandy loam or fine sandy loam. The E part of the 2E&Bt horizon has hue of 10YR or 7.5YR and chroma of 4 to 6.

Kalkaska Series

The Kalkaska series consists of somewhat excessively drained or well drained, rapidly permeable soils. These soils formed in sandy deposits on moraines, till plains, and outwash plains. Slope ranges from 0 to 40 percent.

Kalkaska soils are similar to East Lake and Rubicon soils and are commonly adjacent to East Lake, Manistee, Montcalm, Roscommon, and Tawas soils. East Lake soils have a 2C horizon of gravelly sand. Manistee and Montcalm soils have an argillic horizon. Rubicon soils have a more weakly expressed spodic horizon than Kalkaska soils. Roscommon and Tawas soils are poorly drained or very poorly drained. The Manistee and Montcalm soils are on moraines, till plains, and outwash plains. The Roscommon and Tawas soils are in drainageways and bogs.

A typical pedon of Kalkaska sand, 6 to 12 percent slopes, 1,160 feet east and 200 feet north of the southwest corner of sec. 36, T. 22 N., R. 12 W., in Wexford County:

A—0 to 2 inches; black (10YR 2/1) sand, gray (10YR 5/1) dry; weak very fine granular structure; very friable; many fine and very fine roots; very strongly acid; abrupt smooth boundary.

E—2 to 12 inches; brown (7.5YR 5/2) sand; weak medium granular structure; very friable; many fine and very fine roots; strongly acid; abrupt irregular boundary.

Bh—12 to 16 inches; dark reddish brown (5YR 3/2) sand; weak medium subangular blocky structure; very friable; patches (about 25 percent) of dark reddish brown (5YR 2/2); massive; firm ortstein; many fine and very fine roots; strongly acid; clear irregular boundary.

Bs1—16 to 25 inches; dark brown (7.5YR 3/4) sand; medium and coarse subangular blocky structure; very friable; common fine roots; medium acid; clear wavy boundary.

Bs2—25 to 36 inches; strong brown (7.5YR 5/6) sand; very weak medium subangular blocky structure; very friable; few fine roots; medium acid; clear wavy boundary.

BC—36 to 48 inches; brownish yellow (10YR 6/6) sand; very weak coarse subangular blocky structure; very friable; many fine roots; medium acid; gradual wavy boundary.

C—48 to 60 inches; light yellowish brown (10YR 6/4) sand; very weak medium subangular blocky structure; very friable; medium acid.

The solum ranges from 30 to 50 inches in thickness. It ranges from strongly acid to neutral. Pebble and cobble content dominantly ranges from 0 to 2 percent but ranges to 15 percent in some pedons.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly sand, but the range includes loamy sand. The E horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 1 or 2. It is dominantly sand, but the range includes loamy sand. The Bh horizon has chroma of 2 or 3. It is sand or loamy sand. The Bs horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4 or 6. The BC horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 4 or 6. Bands and layers of loamy sand, sandy loam, loam, loamy fine sand, and silty clay are below a depth of 60 inches in some pedons.

Karlin Series

The Karlin series consists of somewhat excessively drained soils. These soils formed in sandy deposits on outwash plains. Permeability is moderately rapid in the upper part of the pedon and rapid in the lower part. Slope ranges from 0 to 4 percent.

Karlin soils are commonly adjacent to East Lake, Hodenpyl, and Kalkaska soils. East Lake soils are coarser textured than Karlin soils and are calcareous in the lower part of the pedon. Hodenpyl soils are finer textured in the B horizon. Kalkaska soils have a well expressed spodic horizon. East Lake and Kalkaska soils are on knolls and ridges. Hodenpyl soils are on outwash plains.

A typical pedon of Karlin loamy fine sand in an area of Hodenpyl-Karlin complex, 0 to 4 percent slopes, 230 feet west and 65 feet north of the southeast corner of sec. 15, T. 24 N., R. 12 W., in Wexford County:

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; very friable; many fine roots; medium acid; abrupt smooth boundary.

Bs1—9 to 12 inches; dark brown (7.5YR 4/4) loamy fine sand; weak medium subangular blocky structure;

very friable; many fine roots; strongly acid; gradual wavy boundary.

Bs—12 to 19 inches; brown (7.5YR 5/4) loamy fine sand; weak medium subangular blocky structure; very friable; common fine roots; strongly acid; gradual wavy boundary.

BC—19 to 29 inches; brown (7.5YR 5/6) loamy sand; very weak coarse subangular blocky structure; very friable; few fine roots; strongly acid; clear wavy boundary.

C—29 to 60 inches; yellowish brown (10YR 5/6) sand; single grain; loose; medium acid.

The solum ranges from 16 to 35 inches in thickness. It is strongly acid or medium acid.

The Ap horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. It is dominantly loamy fine sand, but the range includes sandy loam and loamy sand. The Bs horizon has value of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 or 6. It is dominantly loamy sand or loamy fine sand, but the range includes sandy loam in the upper part and sand in the lower part. The C horizon has hue of 10YR or 7.5YR and value and chroma of 4 to 6. Pebble content is less than 5 percent pebbles in some pedons.

Kawkawlin Series

The Kawkawlin series consists of somewhat poorly drained soils. These soils formed in loamy and silty glacial deposits on low, smooth ground moraines. Permeability is moderately slow. Slope ranges from 0 to 4 percent.

Kawkawlin soils are commonly adjacent to Allendale, Manistee, Montcalm, Nester, and Roscommon soils. Allendale soils are sandy in the upper part of the pedon. Nester soils are well drained. Manistee and Montcalm soils are well drained sandy soils that have an argillic horizon. Roscommon soils are poorly drained sandy soils. Manistee, Montcalm, and Nester soils are on higher positions in the landscape. Roscommon soils are in lower positions in the landscape. Allendale soils are on low, smooth ground moraines.

A typical pedon of Kawkawlin loam, 0 to 4 percent slopes, 2,565 feet west and 550 feet north of the northeast corner of sec. 1, T. 23 N., R. 10 W., in Wexford County:

Ap—0 to 7 inches; dark gray (10YR 4/1) loam, gray (10YR 5/1) dry; moderate fine subangular blocky structure; friable; many fine roots; neutral; abrupt smooth boundary.

E—7 to 9 inches; grayish brown (10YR 5/2) clay loam; common fine distinct dark yellowish brown (10YR 4/6) mottles; moderate fine subangular blocky structure; firm; many fine roots; neutral; abrupt broken boundary.

B/E—9 to 12 inches; brown (7.5YR 4/4) clay loam (Bt); moderate fine subangular blocky structure; firm; interfingering brown (10YR 5/3) silt loam (E); massive; firm; many fine distinct dark yellowish brown (10YR 4/6) mottles; common fine roots; neutral; clear wavy boundary.

Bt—12 to 24 inches; brown (10YR 4/3) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; strong medium angular blocky structure; very firm; common fine roots; neutral; clear wavy boundary.

Cg—24 to 60 inches; dark yellowish brown (10YR 4/2) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; common fine white patches of free carbonates; moderate medium subangular blocky structure; firm; strong effervescence; moderately alkaline.

The solum ranges from 16 to 30 inches in thickness. It is medium acid to neutral. Pebble content is dominantly less than 2 percent but ranges to 5 percent.

The Ap horizon has value of 2 or 3. It is dominantly loam, but the range includes silty clay loam or clay loam. The E horizon and the E part of the B/E horizon have value of 5 or 6 and chroma of 2 or 3. They are clay loam, silt loam, or silty clay loam. The Bt horizon and the Bt part of the B/A horizon have hue of 7.5YR or 10YR and chroma of 3 or 4. They are clay, clay loam, or silty clay loam. The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 or 3. It is clay loam or silty clay loam. The C horizon is mildly alkaline or moderately alkaline.

Loxley Series

The Loxley series consists of very poorly drained, extremely acid organic soils. These soils formed in herbaceous bog deposits on outwash plains and till plains. Permeability is moderately rapid to moderately slow. Slope is 0 to 2 percent.

Loxley soils are similar to Lupton soils and are commonly adjacent to Au Gres, Croswell, Graycalm, Grayling, and Rubicon soils. The organic Lupton soils are less acid in the subsurface and bottom tiers than the Loxley soils. All of the adjacent soils are sandy, and they are in higher positions in the landscape than Loxley soil.

A typical pedon of Loxley peat, 1,440 feet east and 770 feet south of the northwest corner of sec. 31, T. 21 N., R. 10 W., in Wexford County:

Oi—0 to 4 inches; brown (7.5YR 4/4) broken face and rubbed fibric material, pale brown (10YR 6/3) dry; nearly 100 percent fibers, 95 percent rubbed; many fine roots; about 95 percent sphagnum moss fibers; few partly decomposed woody stems; extremely acid; abrupt smooth boundary.

Oe—4 to 9 inches; dark reddish brown (5YR 3/3) broken face and rubbed hemic material; about 80 percent fibers, 35 percent rubbed; weak coarse granular structure; friable; many fine roots; sphagnum moss and herbaceous fibers; extremely acid; clear smooth boundary.

Oa1—9 to 16 inches; dark reddish brown (5YR 3/2) broken face and rubbed sapric material; about 60 percent fibers, 10 percent rubbed; weak coarse subangular blocky structure; friable; many fine roots; mostly herbaceous fibers; extremely acid; gradual smooth boundary.

Oa2—16 to 35 inches; dark reddish brown (5YR 3/2) broken and rubbed sapric material; about 50 percent fibers, 5 percent rubbed; weak very thick platy structure; friable; common fine roots; mostly herbaceous fibers; extremely acid; gradual smooth boundary.

Oa3—35 to 60 inches; dark reddish brown (5YR 3/2) broken and rubbed sapric material; about 25 percent fibers, 5 percent rubbed; massive; friable; few fine roots; mostly herbaceous fibers; extremely acid.

The surface horizon is dominantly fibric material, but the range includes hemic material. It has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 2 or 3. The rest of the surface tier is dominantly hemic material. All horizons below the surface horizon have hue of 5YR, value of 3, and chroma of 2 or 3. They become darker quickly on exposure to the air.

Lupton Series

The Lupton series consists of very poorly drained organic soils. These soils formed in woody and herbaceous bog deposits on till plains, outwash plains, and moraines. Permeability is moderately rapid to moderately slow. Slope is 0 to 2 percent.

Lupton soils are similar to Loxley soils and commonly adjacent to Au Gres, Croswell, Montcalm, Roscommon, and Tawas soils. The organic Loxley soils are more acid in the subsurface and bottom layers than the Lupton soils. The Au Gres, Croswell, Montcalm, and Roscommon soils are sandy soils. Tawas soils are sandy in the lower part of the pedon. All adjacent soils are in higher positions in the landscape than the Lupton soils.

A typical pedon of Lupton muck, 1,270 feet north and 65 feet east of the southwest corner of sec. 19, T. 21 N., R. 10 W., in Wexford County:

Oa1—0 to 5 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material, very dark gray (10YR 3/1) dry; about 30 percent fiber, 5 percent rubbed; weak coarse granular structure; friable; mostly herbaceous fiber; slightly acid; clear smooth boundary.

Oa2—5 to 14 inches; very dark brown (10YR 2/2) broken face and rubbed sapric material, very dark gray (10YR 3/1) dry; about 30 percent fiber, 5 percent rubbed; weak coarse granular structure; friable; mostly herbaceous fiber; slightly acid; clear smooth boundary.

Oa3—14 to 34 inches; very dark grayish brown (10YR 3/2) broken face and rubbed sapric material; about 40 percent fiber, 10 percent rubbed; weak coarse subangular blocky structure; friable; woody and herbaceous fibers; slightly acid; clear smooth boundary.

Oa4—34 to 42 inches; very dark grayish brown (10YR 3/2) broken face and rubbed sapric material; about 80 percent fibers, 10 percent rubbed; massive; friable; mostly woody fibers; neutral; clear smooth boundary.

Oa5—42 to 60 inches; very dark grayish brown (10YR 3/2) broken face and rubbed sapric material; about 70 percent fibers, 5 percent rubbed; massive; friable; mostly woody fibers; neutral.

The surface layer is dominantly sapric material but includes hemic material. Throughout the pedon, hue is 10YR or 7.5YR, value is 2 or 3, and chroma is 1 or 2. The amount of woody fibers varies widely throughout the pedon and ranges from 10 to 30 percent of the pedon. Reaction ranges from medium acid to mildly alkaline.

Mancelona Series

The Mancelona series consists of somewhat excessively drained soils. Permeability is moderately rapid over very rapid. These soils formed in sandy and gravelly sand deposits on outwash plains. Slope ranges from 0 to 6 percent.

Mancelona soils are similar to East Lake soils and are commonly adjacent to East Lake, Graycalm, Montcalm, and Rubicon soils. East Lake soils do not have an argillic horizon. Graycalm and Montcalm soils do not have a spodic horizon or calcareous underlying material. Rubicon soils do not have an argillic horizon or calcareous underlying material. The Graycalm, Montcalm, and Rubicon soils are dominantly on adjacent knolls and ridges.

A typical pedon of Mancelona loamy sand in an area of Mancelona-East Lake complex, 0 to 6 percent slopes, 1,640 feet north and 680 feet west of the southeast corner of sec. 9, T. 23 N., R. 12 W., in Wexford County:

A—0 to 5 inches; very dark gray (5YR 3/1) loamy sand, dark gray (10YR 4/1) dry; weak medium and fine granular structure; very friable; abundant medium and fine roots; 2 percent pebbles; slightly acid; clear wavy boundary.

E—5 to 7 inches; dark brown (7.5YR 4/2) sand; weak medium subangular blocky structure; very friable; abundant medium and fine roots; 2 percent pebbles; slightly acid; clear broken boundary.

Bhs—7 to 10 inches; dark reddish brown (5YR 3/4) sand; weak medium subangular blocky structure; very friable; abundant medium and coarse roots; 2 percent pebbles; slightly acid; clear wavy boundary.

Bs1—10 to 17 inches; brown (7.5YR 4/4) sand; weak medium subangular blocky structure; very friable; abundant medium and coarse roots; 10 percent pebbles; slightly acid; clear wavy boundary.

Bs2—17 to 23 inches; brown (7.5YR 5/4) gravelly sand; weak medium subangular blocky structure; very friable; common medium and fine roots; 30 percent pebbles; slightly acid; gradual wavy boundary.

E—23 to 28 inches; yellowish brown (10YR 5/4) gravelly sand; very weak medium subangular blocky structure; very friable; common medium and fine roots; 30 percent pebbles; neutral; clear wavy boundary.

Bt—28 to 34 inches; dark reddish brown (5YR 3/4) gravelly sandy loam; moderate medium and coarse subangular blocky structure; friable; common medium and fine roots; 20 percent pebbles; neutral; clear smooth boundary.

2C—34 to 60 inches; yellowish brown (10YR 5/4) very gravelly sand; single grain; loose; few fine roots; 50 percent pebbles; effervescence; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness. It ranges from medium acid to neutral. Pebble content ranges from 1 to 15 percent in the solum.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bs horizon has hue of 5YR or 7.5YR. The Bt horizon has hue of 5YR or 7.5YR and value of 3 or 4. The pebble and cobble content ranges from 5 to 50 percent. The 2C horizon has hue of 10YR or 7.5YR and value of 4 to 6. It is stratified with coarse sand to mostly gravel and cobbles. It ranges from mildly alkaline to strongly alkaline.

Manistee Series

The Manistee series consists of well drained soils. These soils formed in sandy and clayey material on moraines and till plains. They are rapidly permeable in the upper part and slowly permeable in the lower part. Slope ranges from 0 to 12 percent.

Manistee soils are commonly adjacent to Allendale, Graycalm, Kalkaska, Montcalm, and Rubicon soils. Allendale soils are somewhat poorly drained. The Graycalm, Kalkaska, Montcalm, and Rubicon soils are coarser textured in the lower part of the pedon. Allendale, Graycalm, Kalkaska, Montcalm, and Rubicon soils are on moraines and till plains. Allendale soils are slightly lower in the landscape than the Manistee soils.

A typical pedon of Manistee loamy sand in an area of Manistee-Montcalm loamy sands, 0 to 6 percent slopes, 175 feet south and 30 feet west of the northeast corner of sec. 27, T. 22 N., R. 9 W., in Wexford County:

A—0 to 2 inches; very dark gray (10YR 3/1) loamy sand, gray (10YR 5/1) dry; weak medium granular structure; very friable; many fine roots; medium acid; abrupt smooth boundary.

E—2 to 4 inches; grayish brown (10YR 5/2) loamy sand; weak fine subangular blocky structure; very friable; many fine roots; medium acid; abrupt broken boundary.

Bhs—4 to 5 inches; reddish brown (5YR 3/4) loamy sand; weak medium subangular blocky structure; very friable; many fine roots; medium acid; clear wavy boundary.

Bs1—5 to 13 inches; brown (7.5YR 4/4) loamy sand; weak medium subangular blocky structure; very friable; common fine roots; slightly acid; clear wavy boundary.

Bs2—13 to 18 inches; strong brown (7.5YR 5/6) sand; medium subangular blocky structure; very friable; common fine roots; slightly acid; diffused wavy boundary.

E'—18 to 25 inches; brown (10YR 5/3) loamy sand; very weak very thick platy structure; very friable; common fine roots; slightly acid; diffused wavy boundary.

2B/E—25 to 31 inches; brown (10YR 5/3) loamy sand (E'); massive; very friable; surrounding peds of reddish brown (5YR 4/4) sandy clay loam (Bt); moderate medium subangular blocky structure; firm; common fine roots; slightly acid; diffused wavy boundary.

2Bt—31 to 37 inches; brown (7.5YR 4/4) clay; moderate fine angular blocky structure; very firm; thin patchy clay on ped faces; few fine roots; neutral; gradual wavy boundary.

2C—37 to 60 inches; brown (7.5YR 4/4) clay; massive; very firm; slight effervescence; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness. It ranges from strongly acid to slightly acid. Pebble and cobble content ranges from 0 to 5 percent in the sandy upper part of the solum. Cobbles are commonly just above the 2B/E horizon.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loamy sand or sand. The E horizon has hue of 10YR or 7.5YR and value of 5 or 6. The A horizon is dominantly sand, but the range includes loamy sand. The Bh horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. It is loamy sand or sand. The Bs horizon has value of 4 or 5 and chroma of 4 or 6. It is loamy sand or sand. The E horizon and the E part of the 2B/E horizon have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. The 2Bt horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is clay or silty clay. The Bt part of the 2B/E horizon is clay loam, sandy clay loam, silty clay loam, or clay. The 2C horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 or 6. It is clay or silty clay. The 2C horizon ranges from slightly acid to moderately alkaline.

Montcalm Series

The Montcalm series consists of well drained soils. Permeability is moderately rapid. These soils formed in sandy and loamy deposits on till plains and moraines. Slope ranges from 0 to 40 percent.

Montcalm soils are commonly adjacent to Emmet, Graycalm, Kalkaska, Manistee, and Rubicon soils. Emmet soils are moderately permeable. Graycalm soils do not have an argillic horizon. Kalkaska and Rubicon soils have a spodic horizon and are sandy throughout the pedon. Manistee soils are clayey in the lower part. All adjacent soils are on till plains and moraines.

A typical pedon of Montcalm loamy sand in an area of Emmet-Montcalm complex, 12 to 18 percent slopes, 370 feet south and 100 feet west of the northeast corner of sec. 25, T. 21 N., R. 9 W., in Wexford County:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) loamy sand, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; many fine roots; medium acid; clear smooth boundary.

Bw1—7 to 14 inches; brown (10YR 4/3) loamy sand; weak fine subangular blocky structure; very friable; common fine roots; medium acid; gradual wavy boundary.

Bw2—14 to 37 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; common fine roots; medium acid; clear irregular boundary.

E—37 to 42 inches; brown (10YR 5/3) loamy sand; weak fine subangular blocky structure; very friable; common fine roots; slightly acid; clear wavy boundary.

B/E—42 to 60 inches; brown (7.5YR 4/4) sandy loam (Bt); moderate medium subangular blocky structure; friable; brown (10YR 5/3) loamy sand (E); massive; very friable; few fine roots; slightly acid.

The solum is more than 60 inches thick. Depth to the top of the argillic horizon ranges from 30 to 45 inches. Reaction ranges from strongly acid to slightly acid. Pebble and cobble content ranges from 0 to 15 percent.

The Ap horizon has value of 3 or 4. It is dominantly loamy sand, but the range includes sand. The Bw horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 to 6. It is loamy sand or sand. The E horizon and the E part of the B/E horizon have hue of 7.5YR or 10YR, value of 5 or 6, and chroma of 2 or 3. The Bt part of the B/E horizon has hue of 7.5YR or 5YR and value and chroma of 3 or 4.

Nester Series

The Nester series consists of well drained soils that formed in loamy and clayey deposits on till plains and moraines. Permeability is moderately slow. Slope ranges from 1 to 40 percent.

Nester soils are similar to Dighton soils and are commonly adjacent to Allendale, Emmet, Kawkawlin, Manistee, and Montcalm soils. Allendale and Kawkawlin soils are somewhat poorly drained. Dighton soils have sandy underlying material. Manistee soils are sandy in the upper part. Emmet and Montcalm soils are coarser textured throughout the pedon. The nearby and similar soils are on till plains and moraines. Allendale and Kawkawlin soils are in slightly lower positions in the landscape than Nester soil.

A typical pedon of Nester sandy loam, 1 to 6 percent slopes, 1,285 feet west and 75 feet south of the northeast corner of sec. 18, T. 21 N., R. 9 W., in Wexford County:

Ap—0 to 8 inches; dark brown (7.5YR 3/2) sandy loam, light brownish gray (10YR 6/2) dry; weak medium and fine subangular blocky structure; friable; many fine roots; slightly acid; abrupt smooth boundary.

E—8 to 11 inches; brown (10YR 5/3) loam; moderate fine subangular blocky structure; friable; many fine roots; medium acid; diffused wavy boundary.

B/E—11 to 18 inches; brown (10YR 5/3) sandy loam (E); massive; friable; surrounding peds of reddish brown (5YR 4/3) clay loam (B); moderate medium subangular blocky structure; firm; many fine roots; medium acid; diffused wavy boundary.

Bt—18 to 28 inches; dark reddish brown (5YR 3/3) clay loam; strong fine angular blocky structure; very firm; thin continuous clay films on ped faces; common fine roots; neutral; gradual wavy boundary.

C1—28 to 50 inches; reddish brown (5YR 4/3) sandy clay loam; massive; firm; few fine roots; mildly alkaline; gradual wavy boundary.

C2—50 to 60 inches; brown (7.5YR 4/4) clay; massive; firm; slight effervescence; mildly alkaline.

The solum ranges from 20 to 35 inches in thickness. It ranges from slightly acid to neutral. Pebble content dominantly ranges from 0 to 2 percent but ranges to 5 percent in some pedons.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. It is dominantly sandy loam, but the range includes loam. The E horizon has value of 5 or 6 and chroma of 2 or 3. The Bt horizon has hue of 5YR or 7.5YR and value and chroma of 3 or 4. The B/E horizon is clay loam, and the Bt horizon is clay or silty clay. The sandy clay loam C1 horizon is absent in some pedons. The C2 horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. It is clay or silty clay. The C2 horizon is mildly alkaline or moderately alkaline.

Roscommon Series

The Roscommon series consists of very poorly drained soils. These soils formed in sandy deposits in bogs, depressions, and drainageways on outwash plains,

till plains, and moraines. Slope ranges from 0 to 2 percent.

Roscommon soils are commonly adjacent to Au Gres, Graycalm, Lupton, Tawas, and Rubicon soils. Lupton and Tawas soils are organic soils. Au Gres soils are somewhat poorly drained, and Graycalm and Rubicon soils are somewhat excessively drained. Au Gres soils are in slightly higher positions in the landscape than Roscommon soil. Graycalm and Rubicon soils are on knolls and ridges above the Roscommon soil. Lupton and Tawas soils are in bogs, depressions, and drainageways.

A typical pedon of Roscommon mucky sand in an area of Tawas-Roscommon association, 2,580 feet north and 75 feet west of the southeast corner of sec. 12, T. 20 N., R. 11 W., in Lake County:

A—0 to 9 inches; very dark gray (10YR 3/1) mucky sand, gray (10YR 5/1) dry; weak coarse subangular blocky structure; very friable; many fine roots; slightly acid; clear smooth boundary.

Cg—9 to 14 inches; light brownish gray (2.5YR 6/2) sand; single grain; loose; common fine roots; slightly acid; gradual smooth boundary.

C—14 to 60 inches; brown (10YR 5/3) sand; single grain; loose; few fine roots; slightly acid.

The pedon is slightly acid or neutral. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly mucky sand, but the range includes sand. The Cg horizon has hue of 2.5YR or 10YR, value of 4 to 6, and chroma of 1 or 2. The C horizon has value of 4 to 6.

Rubicon Series

The Rubicon series consists of excessively drained, rapidly permeable soils. These soils formed in sandy deposits on moraines, till plains, and outwash plains. Slope ranges from 0 to 40 percent.

Rubicon soils are similar to Croswell and Kalkaska soils and are commonly adjacent to Croswell, Graycalm, Montcalm, and Roscommon soils. Croswell soils are moderately well drained. Graycalm soils have thin argillic bands in the lower part. Kalkaska soils have a more strongly expressed spodic horizon. Montcalm soils have an argillic horizon. Roscommon soils are very poorly drained. Graycalm and Montcalm soils are on moraines, till plains, and outwash plains. Roscommon soils are in depressions or drainageways.

A typical pedon of Rubicon sand, 12 to 40 percent slopes, 1,590 feet south and 850 feet west of the northeast corner of sec. 34, T. 21 N., R. 11 W., in Wexford County:

A—0 to 2 inches; black (10YR 2/1) sand, gray (10YR 4/1) dry; weak fine granular structure; very friable; many fine roots; strongly acid; abrupt smooth boundary.

E—2 to 10 inches; pinkish gray (7.5YR 6/2) sand; weak coarse granular structure; very friable; many fine roots; strongly acid; abrupt wavy boundary.

Bs1—10 to 17 inches; dark brown (7.5YR 4/4) sand; very weak fine subangular blocky structure; very friable; many fine roots; medium acid; clear wavy boundary.

Bs2—17 to 24 inches; yellowish brown (10YR 5/6) sand; very weak medium subangular blocky structure; very friable; common roots; medium acid; clear irregular boundary.

BC—24 to 43 inches; brownish yellow (10YR 6/6) sand; very weak subangular blocky structure; very friable; few roots; medium acid; gradual wavy boundary.

C—43 to 60 inches; very pale brown (10YR 7/4) sand; single grain; loose; slightly acid.

The solum ranges from 24 to 50 inches in thickness. It is very strongly acid to medium acid. Pebble and cobble content ranges from 0 to 5 percent.

The E horizon has hue of 7.5YR or 10YR and value of 5 or 6. The Bs1 horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 4 or 6. The Bs2 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 or 6. The C horizon has hue of 10YR or 7.5YR, value of 6 or 7, and chroma of 3 or 4.

Tawas Series

The Tawas series consists of very poorly drained soils. These soils formed in organic deposits over sand. They are in bogs, depressions, and drainageways on outwash plains, till plains, and moraines. Permeability is moderately slow to moderately rapid in the organic material and rapid in the sand. Slope ranges from 0 to 2 percent.

Tawas soils are similar to Lupton soils and are commonly adjacent to Au Gres, Kalkaska, Roscommon, and Rubicon soils. Lupton soils are composed of organic material throughout the pedon. The other adjacent soils are sandy throughout the pedon. All adjacent soils are higher in the landscape than Tawas soils.

A typical pedon of Tawas muck in an area of Tawas-Roscommon association, 1,440 feet south and 180 feet west of the northeast corner of sec. 12, T. 20 N., R. 11 W., in Lake County:

Oa1—0 to 12 inches; black (10YR 2/1) broken face and rubbed sapric material, very dark gray (10YR 3/1) dry; about 40 percent fibers, 15 percent rubbed; weak coarse granular structure; friable; many fine roots; mostly herbaceous material; medium acid; clear smooth boundary.

Oa—12 to 22 inches; black (10YR 2/1) broken face and rubbed sapric material; about 40 percent fibers, 10

percent rubbed; moderate coarse subangular blocky structure; friable; many fine roots; mostly woody fibers; medium acid; gradual smooth boundary.

Oa3—22 to 34 inches; very dark gray (10YR 3/1) broken face and rubbed sapric material; about 30 percent fibers, 5 percent rubbed; moderate coarse subangular blocky structure; friable; common fine roots; mostly woody fibers; medium acid; gradual smooth boundary.

Oa4—34 to 41 inches; black (10YR 2/1) broken face and rubbed sapric material; about 25 percent fibers, 2 percent rubbed; massive; friable; mostly herbaceous materials; medium acid; abrupt smooth boundary.

2C—41 to 60 inches; light brownish gray (10YR 6/2) sand; single grain; loose; slightly acid.

Depth to the sandy substratum is dominantly 20 to 40 inches, but it ranges from 16 to 50 inches. The surface tier is dominantly sapric material but includes hemic material in some pedons. The organic tiers have hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. The amount of woody and herbaceous fibers varies widely among tiers and among pedons. Reaction ranges from medium acid to mildly alkaline. The 2C horizon has hue of 10YR or 2.5YR, value of 4 to 6, and chroma of 1 or 2. It is sand or loamy sand.

Winterfield Series

The Winterfield series consists of somewhat poorly drained, rapidly permeable soils. These soils formed in sandy deposits on flood plains. Slope ranges from 0 to 3 percent.

Winterfield soils are commonly adjacent to Croswell, Graycalm, Roscommon, Rubicon, and Tawas soils. Croswell soils are moderately well drained; Graycalm and Rubicon soils are somewhat excessively drained; Roscommon and Tawas soils are very poorly drained. Croswell, Graycalm, Roscommon, and Rubicon soils are on uplands. Tawas soils are in adjacent drainageways.

A typical pedon of Winterfield sand, 2,600 feet west and 1,280 feet south of the northeast corner of sec. 17, T. 17 N., R. 13 W., in Lake County:

A—0 to 8 inches; very dark gray (10YR 3/1) sand; weak medium and fine granular structure; very friable; many fine roots; medium acid; abrupt smooth boundary.

C1—8 to 21 inches; yellowish brown (10YR 5/4) sand, dark gray (10YR 2/1) dry; common fine faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; common fine roots; slightly acid; clear wavy boundary.

C2—21 to 36 inches; brown (10YR 5/3) sand; common fine faint yellowish brown (10YR 5/6) and few fine faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; very friable; common fine roots; neutral; clear wavy boundary.

C3—36 to 48 inches; brown (7.5YR 5/4) loamy sand; few fine faint strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; few fine roots; neutral; clear wavy boundary.

C4—48 to 60 inches; yellowish brown (10YR 5/4) sand; many coarse faint yellowish brown (10YR 5/6) mottles; single grain; loose; mildly alkaline.

The A horizon has hue of 10YR or 7.5YR and value and chroma of 1 to 3. The C horizon has hue of 10YR or 7.5YR and value and chroma of 4 to 6. Texture is dominantly sand, but layers of gravel and cobbles or gravelly coarse sand are common. The C horizon is medium acid to mildly alkaline.

Formation of the Soils

The paragraphs that follow describe the factors of soil formation, relate them to the formation of the soils in the survey area, and explain the processes of soil formation.

Factors of Soil Formation

Soil forms through the interaction of five major factors: the physical, chemical, and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land, including the depth to the water table; and the length of time the processes of soil formation have acted on the parent material (*4*).

Climate and plant and animal life are the active forces in soil formation. They slowly change the parent material into a natural body of soil that has genetically related layers, called horizons. The effects of climate and plant and animal life are conditioned by relief. The nature of the parent material also affects the kind of soil profile that is formed and, in extreme cases, determines it almost entirely. Finally, time is needed to change the parent material into a soil profile. It can be a long or short time, but some time is required for differentiation of soil horizons. Generally, a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soils that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent Material

Parent material is the unconsolidated mass from which a soil forms. The parent material of the soils of Lake and Wexford Counties was deposited by glaciers or melt water from the glaciers. The parent material was reworked by subsequent actions of water and wind. Glaciers covered the area about 10,000 to 12,000 years ago. Parent material determines the limit of the chemical and mineralogical composition of the soil. Although most of the parent material is of common glacial origin, its properties vary greatly, sometimes within small areas, depending upon how the material was deposited. The dominant parent material in Lake and Wexford Counties was deposited as glacial till, outwash deposits, alluvium, and organic material.

Glacial till is material laid down directly by glaciers with a minimum of water action. It consists of particles of different sizes that are mixed together. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water washing.

The glacial till in Lake and Wexford Counties contains a wide range of rock material that originated from the bedrock over which the glacier flowed. The glacial till is dominantly deeply leached of carbonates. The till is loamy sand, sandy loam, loam, clay loam, silty clay, and clay. The Emmet, Montcalm, and Nester soils, for example, formed in glacial till.

Outwash material was deposited by running water from melting glaciers. The size of the particles that make up outwash material depends upon the speed of the stream of water that carried them. When the water slows down, the coarser particles are deposited. Finer particles, such as very fine sand, silt, and clay, can be carried by slowly moving water. Outwash deposits generally consist of layers of particles of similar size. Most of the outwash deposits in Lake and Wexford Counties are sand. Grayling soil, for example, formed in deposits of outwash material.

Alluvial material has been deposited by floodwaters of present streams in recent time. This material has various textures, depending upon the speed of the water from which it was deposited. An example of an alluvial soil is the Winterfield soil.

Organic material consists of deposits of plant remains. After the glaciers withdrew from the area, water remained standing in depressions on outwash plains, flood plains, moraines, and till plains. Grasses and sedges growing around the edges of the lakes died, and the residue fell to the bottom. Because the areas were wet, the plant remains did not decompose, but remained around the edge of the lake. Later, water-tolerant trees grew in these areas. After these trees died, the residue became part of the organic material and formed areas of muck. Loxley, Lupton, and Tawas soils are examples of soils that formed in organic material.

Plant and Animal Life

Green plants have been the principal organism influencing the soils in Lake and Wexford Counties. Bacteria, fungi, earthworms, and the activities of man, however, have also been important. The chief contribution of plant and animal life is the addition of

organic matter and nitrogen to the soil. The kind of organic material on and in the soil depends upon the kinds of plants that grew on the soil, died and decayed, and eventually became organic matter. Roots of the plants provide channels for downward movement of water through the soil and also add organic matter as they decay. Bacteria in the soil help to break down the organic matter so that it can be used by growing plants.

The vegetation of Lake and Wexford Counties was mostly pine and deciduous forest. Differences in natural soil drainage and changes in parent material affect the composition of forest species.

In general, well drained upland soils, such as Emmet and Kalkaska soils, were covered mainly with sugar maple, beech, and yellow birch trees. Other well drained and somwhat excessively drained upland soils, such as Montcalm, Graycalm, and Rubicon soils, were covered mainly with white pine. An excessively drained soil, such as Grayling soil, was covered mainly with jack pine and scrub oak. The wet soils, such as Au Gres and Roscommon soils, were covered mainly with red maple, paper birch, elm, black ash, hemlock, balsam fir, and northern white-cedar.

Climate

Climate is important in the formation of soils. It determines the kind of plant and animal life on and in the soil, and it determines the amount of water available for weathering minerals and for transporting soil material. Climate, by its influence on soil temperature, determines the rate of chemical reaction in the soil. These influences are important but affect large areas rather than a relatively small area, such as the survey area.

The climate in Lake and Wexford Counties is cool and humid. This is presumably similar to that which existed when the soils formed. The soils of this area differ from soils that formed in a dry, warm climate or from those that formed in a moist, hot climate. Climate is uniform throughout Lake and Wexford Counties. Only minor differences in the soils are the result of differences in climate.

Relief

Relief, or topography, affects the natural drainage of the soils, the rate of erosion, the kind of plant cover, and the soil temperature. In Lake and Wexford Counties, slope ranges from 0 to 40 percent. Surface runoff is most rapid on steep slopes. Surface water accumulates in low areas.

Drainage partly determines the color of the soil by its effect on aeration of the soil. Water and air move freely through soils that are well drained and slowly through soils that are poorly drained. In soils that are well aerated, the iron and aluminum compounds that give most of the soils their color are oxidized and brightly colored. In poorly aerated soils, the color is dull gray and mottled. Kalkaska soil is an example of a well drained, well aerated soil. Roscommon soil is an example of a poorly drained, poorly aerated soil. Both soils formed in similar parent material.

Time

Generally, a long time is required to develop distinct horizons from parent material. The differences in the length of time that the parent material has been in place are commonly reflected in the degree of development of the soil profile. Some soils form rapidly and other soils develop slowly.

The soils in Lake and Wexford Counties range from young to mature. The glacial deposits from which many of the soils formed have been exposed to soil-forming agents long enough to allow distinct horizons to develop. Some soils forming in recent alluvial sediment have not been in place long enough for distinct horizons to develop. The Winterfield soil is an example of a young soil that formed in alluvial material. The Emmet soil has had more time to leach the lime content; therefore, horizons have had more time to develop.

Processes of Soil Formation

The processes responsible for the development of the soil horizons from the unconsolidated parent material are referred to as soil genesis. The physical, chemical, and biological properties of the horizons are referred to as soil morphology.

Several processes were involved in the development of horizons in the soils of Lake and Wexford Counties: (1) the accumulation of organic matter, (2) the leaching of lime (calcium carbonate) and other bases, (3) the reduction and transfer of iron, (4) the formation and translocation of silicate clay minerals, and (5) the translocation of aluminum, iron, and humus. In most of the soils of the survey area more than one of these processes have been active in the development of horizons.

As organic matter accumulates on the surface of a soil, an A horizon is formed. If the soil is plowed, the A horizon is mixed into the plow layer, or Ap horizon. In the soils of Lake and Wexford Counties, the surface layer ranges from high to low in content of organic matter. The Allendale soil, for example, has high content of organic matter. The Grayling soil has low content.

Carbonates and other bases have been leached in most of the soils. The leaching of bases in soils generally preceded the translocation of silicate clay minerals. Many of the soils in Lake and Wexford Counties have been moderately leached to strongly leached. For example, the Montcalm soil is leached of carbonates to a depth of more than 60 inches, whereas the Kalkaska soil is leached to a depth of only 24 inches. The difference in the depth of leaching is a result of time and parent material as soil-forming factors.

The reduction and transfer of iron, a process called gleying, is evident in the somewhat poorly drained, poorly drained, and very poorly drained soils. The dull gray subsoil indicates the reduction and loss of iron. The Roscommon soil is an example of strong gleying.

The translocation of clay minerals has contributed to horizon development. The eluviated, or leached, E horizon typically has a platy structure, is lower in content of clay, and typically is lighter in color than the illuviated Bt horizon. The Bt horizon typically has an accumulation of clay or clay films in pores and on the faces of peds. These soils were probably leached of carbonates and soluble salts to a considerable extent before the translocation of silicate clays. The leaching of bases and the translocation of silicate clays are among the more important processes in horizon differentiation in soils. The Emmet soil has translocated silicate clays in the form of clay films accumulated in the B horizon.

In some soils in Lake and Wexford Counties, aluminum, iron, and humus have moved from the surface horizon and have accumulated in the Bh or Bs horizons. The eluviated E horizon is highly leached and grayish. The illuviated B horizon is dark reddish brown. Kalkaska soil is an example of such soils.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Geib, W.J. 1909. Soil survey of Wexford County, Michigan. U.S. Dep. Agric., Bur. of Soils. 20 pp., illus.

(4) Jenny, Hans. 1941. Factors of soil formation. McGraw-Hill Book Company, Inc., 281 pp., illus.

(5) Makma, D.L., E.P. Whiteside, and I.F. Schneider. 1978. Soil management units and land use planning. Mich. State Univ. Bull. E-1262. 12 pp.

(6) Michigan State University. 1976. Fertilizer recommendations for vegetables and field crops in Michigan. Ext. Bull. E-550, 20 pp.

(7) Powers, Perry F. 1912. A history of northern Michigan and its people. The Lewis Publ. Co., Vol. 1. 555 pp.

(8) United States Department of Commerce. 1978. United States census of agriculture. Vol. 1, Part 22.

(9) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(10) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(11) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from

seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess alkali (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these minerals.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

R layer.—Soft, consolidated bedrock below the soil.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Irrigation. Application of water to soils to assist in production of crops. A method of irrigation is—

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting (in tables). Pits caused by melting ground ice. They form on the soil after plant cover is removed.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of

separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded and 6 to 15 inches (15 to 38 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. Includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-80 at Cadillac and Baldwin]

Month	Temperature: Average daily maximum	Temperature: Average daily minimum	Temperature: Average daily	Temperature: 2 years in 10 will have-- Maximum temperature higher than--	Temperature: 2 years in 10 will have-- Minimum temperature lower than--	Temperature: Average number of growing degree days[1]	Precipitation: Average	Precipitation: 2 years in 10 will have-- Less than--	Precipitation: 2 years in 10 will have-- More than--	Precipitation: Average number of days with 0.10 inch or more	Precipitation: Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
CADILLAC:											
January---	24.8	9.5	17.2	47	-23	0	1.62	1.0	2.2	5	18.0
February--	27.4	7.9	17.6	47	-23	0	1.38	.7	1.9	4	12.6
March-----	36.8	17.0	26.9	63	-15	1	2.03	1.0	2.9	6	11.2
April-----	52.2	30.4	41.3	79	5	38	3.03	1.9	4.1	7	3.9
May-------	65.6	40.2	52.9	86	20	176	2.54	1.6	3.4	6	.1
June------	74.7	49.9	62.3	91	30	381	3.07	1.5	4.4	6	0
July------	78.8	53.6	66.2	92	36	511	3.20	1.8	4.4	6	0
August----	76.7	52.4	64.6	91	33	460	3.06	1.5	4.4	6	0
September-	68.1	45.5	56.8	88	25	238	3.48	1.6	5.1	7	T
October---	56.8	36.8	46.8	79	18	79	2.87	1.5	4.1	7	.7
November--	41.8	27.0	34.4	66	0	7	2.69	1.7	3.6	7	8.7
December--	29.8	15.4	22.6	53	-14	0	1.84	1.3	2.4	5	16.0
Year----	52.8	32.1	42.5	94	-26	1,891	30.81	26.9	34.6	72	71.2
BALDWIN:											
January---	29.0	11.1	20.1	51	-24	0	2.29	1.5	3.0	7	25.0
February--	32.1	9.4	20.8	51	-22	0	1.68	1.0	2.3	5	16.3
March-----	41.9	18.7	30.3	70	-15	9	2.18	1.3	3.0	6	10.9
April-----	57.3	31.3	44.3	82	10	61	3.19	2.2	4.1	8	1.9
May-------	70.5	42.0	56.3	89	21	247	2.93	1.7	4.0	7	.1
June------	79.3	51.0	65.1	95	30	463	3.27	1.5	4.8	7	0
July------	83.1	54.7	68.9	95	37	593	2.88	1.7	3.9	6	0
August----	80.9	53.2	67.0	94	35	536	3.62	1.7	5.3	7	0
September-	72.3	46.1	59.2	91	26	297	3.29	1.5	4.8	7	0
October---	61.0	36.6	48.8	82	17	102	3.00	1.5	4.3	7	.5
November--	45.8	27.4	36.6	69	2	38	3.20	1.8	4.5	8	10.0
December--	33.5	17.0	25.3	56	-12	0	2.44	1.5	3.3	8	18.0
Year----	57.2	33.2	45.2	97	-26	2,346	33.98	30.4	37.5	83	82.6

[1]A growing degree day is an index of the amount of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-80 at Cadillac and Baldwin]

Probability	Dates for given probability and temperature: 24° F or lower	28° F or lower	32° F or lower
CADILLAC:			
Last freezing temperature in spring:			
1 year in 10 later than--	May 21	June 6	June 25
2 years in 10 later than--	May 15	May 30	June 18
5 years in 10 later than--	May 4	May 18	June 5
First freezing temperature in fall:			
1 year in 10 earlier than--	September 21	September 8	August 20
2 years in 10 earlier than--	September 30	September 16	August 28
5 years in 10 earlier than--	October 17	October 1	September 12
BALDWIN:			
Last freezing temperature in spring:			
1 year in 10 later than--	May 15	May 27	June 18
2 years in 10 later than--	May 11	May 23	June 11
5 years in 10 later than--	May 4	May 14	May 30
First freezing temperature in fall:			
1 year in 10 earlier than--	October 2	September 17	September 4
2 years in 10 earlier than--	October 7	September 22	September 8
5 years in 10 earlier than--	October 18	September 30	September 17

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-80 at Cadillac and Baldwin]

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
CADILLAC:			
9 years in 10	129	104	64
8 years in 10	141	114	75
5 years in 10	165	135	98
2 years in 10	189	156	121
1 year in 10	202	167	133
BALDWIN:			
9 years in 10	144	123	85
8 years in 10	151	128	93
5 years in 10	166	138	109
2 years in 10	181	148	124
1 year in 10	189	154	133

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Lake County	Wexford County	Total-- Area	Total-- Extent
		Acres	Acres	Acres	Pct
10A	Au Gres-Finch sands, 0 to 4 percent slopes	6,160	5,490	11,650	1.6
11A	Croswell sand, 0 to 4 percent slopes	16,270	12,325	28,595	3.9
12B	Emmet-Montcalm complex, 0 to 6 percent slopes	5,030	3,000	8,030	1.1
12C	Emmet-Montcalm complex, 6 to 12 percent slopes	4,530	3,770	8,300	1.1
12D	Emmet-Montcalm complex, 12 to 18 percent slopes	1,990	3,760	5,750	0.8
12E	Emmet-Montcalm complex, 18 to 40 percent slopes	850	2,535	3,385	0.5
13B	Grayling sand, 0 to 6 percent slopes	30,235	200	30,435	4.1
14A	Allendale loamy sand, 0 to 4 percent slopes	2,490	5,980	8,470	1.2
15B	Kalkaska sand, 0 to 6 percent slopes	1,010	36,775	37,785	5.1
15C	Kalkaska sand, 6 to 12 percent slopes	1,360	23,955	25,315	3.4
15E	Kalkaska sand, 12 to 40 percent slopes	1,200	34,635	35,835	4.9
16B	Hodenpyl-Karlin complex, 0 to 4 percent slopes	0	7,820	7,820	1.1
17A	Kawkawlin loam, 0 to 4 percent slopes	2,780	2,450	5,230	0.7
18	Loxley peat	2,030	2,080	4,110	0.6
19	Lupton muck	3,970	6,490	10,460	1.4
20B	Montcalm-Graycalm complex, 0 to 6 percent slopes	24,820	38,500	63,320	8.6
20C	Montcalm-Graycalm complex, 6 to 12 percent slopes	27,020	21,580	48,600	6.6
20E	Montcalm-Graycalm complex, 12 to 30 percent slopes	26,160	18,395	44,555	6.1
21B	Nester sandy loam, 1 to 6 percent slopes	1,960	850	2,810	0.4
21C	Nester sandy loam, 6 to 12 percent slopes	1,590	570	2,160	0.3
21E	Nester loam, 12 to 40 percent slopes	650	390	1,040	0.1
22	Tawas-Roscommon association	32,950	24,625	57,575	7.8
23B	Rubicon sand, 0 to 12 percent slopes	48,675	35,595	84,270	11.5
23E	Rubicon sand, 12 to 40 percent slopes	17,660	14,070	31,730	4.3
24D	Rubicon sand, 12 to 40 percent slopes, severely eroded	600	790	1,390	0.2
25	Pits	180	360	540	0.1
26B	Manistee-Montcalm loamy sands, 0 to 6 percent slopes	2,450	5,780	8,230	1.1
26C	Manistee-Montcalm loamy sands, 6 to 12 percent slopes	1,720	1,210	2,930	0.4
28C	Dighton loam, 6 to 12 percent slopes	40	540	580	0.1
29B	Graycalm-Grayling sands, 0 to 6 percent slopes	80,230	7,590	87,820	12.1
29D	Graycalm-Grayling sands, 6 to 30 percent slopes	15,240	80	15,320	2.1
30B	Kalkaska-East Lake sands, 0 to 6 percent slopes	170	5,550	5,720	0.8
30C	Kalkaska-East Lake sands, 6 to 12 percent slopes	30	870	900	0.1
30E	Kalkaska-East Lake sands, 12 to 30 percent slopes	12	4,010	4,022	0.5
34	Winterfield sand	1,800	43	1,843	0.3
35B	Mancelona-East Lake complex, 0 to 6 percent slopes	240	740	980	0.1
36B	Kalkaska sand, banded substratum, 0 to 6 percent slopes	0	3,250	3,250	0.4
36C	Kalkaska sand, banded substratum, 6 to 12 percent slopes	0	11,010	11,010	1.5
36E	Kalkaska sand, banded substratum, 12 to 40 percent slopes	0	6,135	6,135	0.8
37	Fluvaquents and Histosols	1,210	4,090	5,300	0.7
	Water	3,960	6,920	10,880	1.5
	Total	369,272	364,808	734,080	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Pasture
	Bu	Tons	Bu	Bu	Tons	AUM*
10A------------------------ Au Gres-Finch	49	10	43	24	2.2	4.0
11A------------------------ Croswell	50	8	40	25	2.5	5.0
12B------------------------ Emmet-Montcalm	78	14	63	37	3.6	7.0
12C------------------------ Emmet-Montcalm	68	13	58	31	3.3	6.0
12D------------------------ Emmet-Montcalm	65	12	55	30	3.2	6.0
12E------------------------ Emmet-Montcalm	---	---	---	---	---	---
13B------------------------ Grayling	---	---	---	---	---	---
14A------------------------ Allendale	70	11	65	30	2.8	5.0
15B------------------------ Kalkaska	45	7	35	18	1.8	3.0
15C------------------------ Kalkaska	---	---	---	---	1.6	3.0
15E------------------------ Kalkaska	---	---	---	---	---	---
16B------------------------ Hodenpyl-Karlin	73	13	68	32	3.1	6.0
17A------------------------ Kawkawlin	85	16	80	42	3.6	7.0
18------------------------- Loxley	---	---	---	---	---	---
19------------------------- Lupton	---	---	---	---	---	---
20B------------------------ Montcalm-Graycalm	50	10	50	23	2.0	4.0
20C------------------------ Montcalm-Graycalm	---	---	---	---	2.7	5.0
20E------------------------ Montcalm-Graycalm	---	---	---	---	---	---
21B------------------------ Nester	80	14	75	40	3.3	6.0
21C------------------------ Nester	70	13	70	36	3.1	6.0
21E------------------------ Nester	---	---	---	---	---	---

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Corn silage	Oats	Winter wheat	Grass-legume hay	Pasture
	Bu	Tons	Bu	Bu	Tons	AUM*
22: Tawas-Roscommon	---	---	---	---	---	---
23B: Rubicon	---	---	---	---	---	---
23E, 24D: Rubicon	---	---	---	---	---	---
25**. Pits						
26B: Manistee-Montcalm	70	13	67	33	3.3	6.0
26C: Manistee-Montcalm	65	11	62	29	3.1	6.0
28C: Dighton	80	14	75	40	3.6	7.0
29B: Graycalm-Grayling	---	---	---	---	---	---
29D: Graycalm-Grayling	---	---	---	---	---	---
30B: Kalkaska-East Lake	45	7	35	---	1.8	3.0
30C: Kalkaska-East Lake	---	---	---	---	1.6	3.0
30E: Kalkaska-East Lake	---	---	---	---	---	---
34: Winterfield	---	---	---	---	---	---
35B: Mancelona-East Lake	58	10	48	---	2.4	5.0
36B: Kalkaska	45	7	35	18	1.8	3.0
36C: Kalkaska	---	---	---	---	1.6	3.0
36E: Kalkaska	---	---	---	---	---	---
37: Fluvaquents and Histosols	---	---	---	---	---	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Dashes indicate no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I:				
Lake County	---	---	---	---
Wexford County	---	---	---	---
II:				
Lake County	9,770	6,990	2,780	---
Wexford County	14,120	11,670	2,450	---
III:				
Lake County	37,640	7,880	2,490	27,270
Wexford County	56,350	6,090	5,980	44,280
IV:				
Lake County	52,860	29,010	6,160	17,690
Wexford County	89,470	25,340	5,490	58,640
V:				
Lake County	3,970	---	3,970	---
Wexford County	6,490	---	6,490	---
VI:				
Lake County	221,140	27,660	32,950	160,530
Wexford County	125,165	21,320	24,625	79,220
VII:				
Lake County	38,542	---	3,830	34,712
Wexford County	61,843	---	2,123	59,720
VIII:				
Lake County	---	---	---	---
Wexford County	---	---	---	---

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Trees to plant
10A*:								
Au Gres	2w	Slight	Moderate	Slight	Slight	Quaking aspen	70	White spruce, Carolina poplar, eastern white pine, northern white-cedar, Norway spruce.
						Bigtooth aspen	---	
						Balsam fir	---	
						Paper birch	---	
						Yellow birch	---	
						Red maple	---	
						Eastern hemlock	---	
						Eastern white pine	---	
						Northern white-cedar	---	
Finch	3w	Slight	Moderate	Moderate	Severe	Quaking aspen	56	Eastern white pine, white spruce, red pine.
						Northern red oak	56	
						Paper birch	54	
						Red maple	56	
						Eastern white pine	53	
						Sugar maple	53	
11A Croswell	2s	Slight	Slight	Moderate	Slight	Quaking aspen	68	Red pine, eastern white pine, Norway spruce, Carolina poplar.
						Red pine	55	
						Jack pine	53	
						Northern red oak	---	
						Black cherry	---	
						Eastern white pine	---	
						Bigtooth aspen	---	
						Red maple	---	
12B*, 12C*, 12D*:								
Emmet	2o	Slight	Slight	Slight	Slight	Quaking aspen	66	Carolina poplar, red pine, eastern white pine, Norway spruce.
						Sugar maple	---	
						Yellow birch	---	
						Red pine	---	
						American basswood	---	
						American beech	---	
						Eastern white pine	---	
						Northern red oak	---	
Montcalm	2s	Slight	Slight	Moderate	Slight	Sugar maple	61	Red pine, eastern white pine, Carolina poplar, Norway spruce.
						Yellow birch	---	
						Northern red oak	66	
						Eastern white pine	---	
						Red pine	---	
12E*:								
Emmet	2r	Moderate	Moderate	Slight	Slight	Quaking aspen	66	Carolina poplar, red pine, eastern white pine, Norway spruce.
						Sugar maple	---	
						Yellow birch	---	
						Red pine	---	
						American basswood	---	
						American beech	---	
						Eastern white pine	---	
						Northern red oak	---	
Montcalm	2r	Moderate	Moderate	Moderate	Slight	Sugar maple	61	Red pine, eastern white pine, Carolina poplar, Norway spruce.
						Yellow birch	---	
						Northern red oak	66	
						Eastern white pine	---	
						Red pine	---	
13B Grayling	4s	Slight	Moderate	Severe	Slight	Jack pine	48	Jack pine, red pine.
						Northern pin oak	43	
						White oak	---	
						Red pine	---	
						Quaking aspen	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
14A: Allendale	3w	Slight	Moderate	Slight	Moderate	Quaking aspen	60	White spruce, eastern white pine, Carolina poplar, Norway spruce.
						White ash	---	
						Eastern white pine	---	
						White spruce	---	
						Paper birch	---	
						Eastern white pine	---	
						Balsam fir	---	
						Red maple	---	
15B, 15C: Kalkaska	2s	Slight	Moderate	Moderate	Slight	Sugar maple	62	Red pine, Carolina poplar, eastern white pine.
						Quaking aspen	---	
						Red pine	---	
						Eastern white pine	---	
						American beech	---	
						Paper birch	---	
						Northern red oak	---	
15E: Kalkaska	2r	Moderate	Moderate	Moderate	Slight	Sugar maple	62	Red pine, Carolina poplar, eastern white pine.
						Quaking aspen	---	
						Red pine	---	
						Eastern white pine	---	
						American beech	---	
						Paper birch	---	
						Northern red oak	---	
16B*:								
Hodenpyl	2o	Slight	Slight	Slight	Slight	Sugar maple	60	Norway spruce, red pine, eastern white pine, Carolina poplar.
						American beech	---	
						Black cherry	---	
						Eastern hemlock	---	
						Northern red oak	---	
Karlin	2o	Slight	Slight	Slight	Slight	Sugar maple	61	Red pine, eastern white pine, Carolina poplar.
						Yellow birch	---	
						Bigtooth aspen	---	
						Northern red oak	---	
						American basswood	---	
						Red pine	---	
						Eastern white pine	---	
17A: Kawkawlin	2w	Slight	Moderate	Slight	Slight	Sugar maple	61	White spruce, red pine, Norway spruce, eastern white pine, Carolina poplar.
						Northern red oak	---	
						Swamp white oak	---	
						Red maple	---	
						White ash	---	
						American basswood	---	
						Quaking aspen	---	
						Bigtooth aspen	---	
19: Lupton	4w	Slight	Severe	Severe	Severe	Black spruce	20	
						Balsam fir	46	
						Black ash	---	
						Northern white-cedar	---	
						Paper birch	---	
						Tamarack	---	
						Quaking aspen	---	
20B*, 20C*:								
Montcalm	2s	Slight	Slight	Moderate	Slight	Sugar maple	61	Red pine, eastern white pine, Carolina poplar, Norway spruce.
						Yellow birch	---	
						Northern red oak	66	
						Eastern white pine	---	
						Red pine	---	
						Red maple	---	
Graycalm	2s	Slight	Moderate	Severe	Slight	Bigtooth aspen	70	Red pine, eastern white pine, Carolina poplar, white spruce.
						Northern red oak	---	
						Jack pine	56	
						Red pine	64	
						Paper birch	---	
						Eastern white pine	---	
						American beech	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
20E*:								
Montcalm----------	2r	Moderate	Moderate	Moderate	Slight	Sugar maple---------	61	Red pine, eastern white pine, Carolina poplar, Norway spruce.
						Yellow birch--------	---	
						Northern red oak----	66	
						Eastern white pine--	---	
						Red pine------------	---	
						Red maple-----------	---	
Graycalm----------	2r	Moderate	Moderate	Severe	Slight	Bigtooth aspen------	70	Red pine, eastern white pine, Carolina poplar, white spruce.
						Northern red oak----	---	
						Jack pine-----------	56	
						Red pine------------	64	
						Paper birch---------	---	
						Eastern white pine--	---	
						American beech------	---	
21B, 21C----------- Nester	2o	Slight	Slight	Slight	Slight	Sugar maple---------	61	White spruce, red pine, Norway spruce, eastern white pine, Carolina poplar.
						Quaking aspen-------	---	
						White ash-----------	---	
						American basswood---	---	
						Northern red oak----	---	
						White oak-----------	---	
						Black cherry--------	---	
						American beech------	---	
21E---------------- Nester	2r	Moderate	Moderate	Slight	Slight	Sugar maple---------	61	White spruce, red pine, Norway spruce, eastern white pine, Carolina poplar.
						Quaking aspen-------	---	
						White ash-----------	---	
						American basswood---	---	
						Northern red oak----	---	
						White oak-----------	---	
						Black cherry--------	---	
						American beech------	---	
22*:								
Tawas-------------	5w	Slight	Severe	Severe	Severe	Balsam fir----------	40	
						Northern white-cedar	---	
						Quaking aspen-------	---	
						Black ash-----------	---	
						Red maple-----------	---	
Roscommon---------	3w	Slight	Severe	Severe	Moderate	Quaking aspen-------	58	
						Black spruce--------	---	
						Northern white-cedar	---	
						Jack pine-----------	---	
						Silver maple--------	---	
						Red maple-----------	---	
						Yellow birch--------	---	
						Balsam fir----------	---	
						Eastern hemlock-----	---	
23B---------------- Rubicon	3s	Slight	Moderate	Severe	Slight	Red pine------------	50	Red pine, eastern white pine, jack pine.
						Bigtooth aspen------	---	
						Balsam fir----------	---	
						Jack pine-----------	48	
						Northern red oak----	---	
						Quaking aspen-------	---	
						Red maple-----------	---	
						Paper birch---------	---	
						Eastern white pine--	45	
23E, 24D----------- Rubicon	3r	Moderate	Moderate	Severe	Slight	Red pine------------	50	Red pine, eastern white pine, jack pine.
						Bigtooth aspen------	---	
						Balsam fir----------	---	
						Jack pine-----------	48	
						Northern red oak----	---	
						Quaking aspen-------	---	
						Red maple-----------	---	
						Paper birch---------	---	
						Eastern white pine--	45	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
26B*, 26C*:								
Manistee	2s	Slight	Slight	Moderate	Slight	Sugar maple	61	Red pine, eastern white pine, Carolina poplar.
						Eastern white pine	---	
						Red maple	---	
						Red pine	---	
						American basswood	---	
						Eastern hemlock	---	
						Northern red oak	---	
						White ash	---	
Montcalm	2s	Slight	Slight	Moderate	Slight	Sugar maple	61	Red pine, eastern white pine, Carolina poplar, Norway spruce.
						Yellow birch	---	
						Northern red oak	66	
						Eastern white pine	---	
						Red pine	---	
28C Dighton	2o	Slight	Slight	Slight	Slight	Sugar maple	64	White spruce, red pine, Norway spruce, Carolina poplar, eastern white pine.
						Quaking aspen	---	
						White ash	---	
						Black cherry	---	
						American basswood	---	
						Northern red oak	---	
29B*:								
Graycalm	2s	Slight	Moderate	Severe	Slight	Bigtooth aspen	70	Red pine, eastern white pine, Carolina poplar, white spruce.
						Northern red oak	---	
						Jack pine	56	
						Red pine	64	
						Paper birch	---	
						Eastern white pine	---	
						American beech	---	
Grayling	4s	Slight	Moderate	Severe	Slight	Jack pine	48	Jack pine, red pine.
						Northern pin oak	43	
						White oak	---	
						Red pine	---	
						Quaking aspen	---	
29D*:								
Graycalm	2r	Moderate	Moderate	Severe	Slight	Bigtooth aspen	70	Red pine, eastern white pine, Carolina poplar, white spruce.
						Northern red oak	---	
						Jack pine	56	
						Red pine	64	
						Paper birch	---	
						Eastern white pine	---	
						American beech	---	
Grayling	4s	Moderate	Moderate	Severe	Slight	Jack pine	48	Jack pine, red pine.
						Northern pin oak	43	
						White oak	---	
						Red pine	---	
						Quaking aspen	---	
30B*, 30C*:								
Kalkaska	2s	Slight	Moderate	Moderate	Slight	Sugar maple	62	Red pine, Carolina poplar, eastern white pine.
						Quaking aspen	---	
						Red pine	---	
						Eastern white pine	---	
						American beech	---	
						Paper birch	---	
East Lake	3s	Slight	Moderate	Severe	Slight	Sugar maple	53	Red pine, white spruce, jack pine.
						Northern red oak	---	
						Quaking aspen	---	
						Red pine	55	
						Jack pine	---	
						Paper birch	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordi- nation symbol	Management concerns: Erosion hazard	Equip- ment limita- tion	Seedling mortal- ity	Wind- throw hazard	Potential productivity: Common trees	Site index	Trees to plant
30E*:								
Kalkaska	2r	Moderate	Moderate	Moderate	Slight	Sugar maple	62	Red pine, Carolina poplar, eastern white pine.
						Quaking aspen	---	
						Red pine	---	
						Eastern white pine	---	
						American beech	---	
						Paper birch	---	
East Lake	3r	Moderate	Severe	Severe	Slight	Sugar maple	53	Red pine, white spruce, jack pine.
						Northern red oak	---	
						Quaking aspen	---	
						Red pine	55	
						Jack pine	---	
						Paper birch	---	
34 Winterfield	3o	Slight	Moderate	Slight	Slight	Quaking aspen	60	White spruce, eastern white pine, black spruce, northern white-cedar.
						Paper birch	---	
						White spruce	---	
						Red maple	---	
						Balsam fir	---	
						Black spruce	---	
						Eastern white pine	---	
35B*:								
Mancelona	2s	Slight	Slight	Moderate	Slight	Sugar maple	61	Red pine, eastern white pine.
						Northern red oak	---	
						Red pine	---	
						Jack pine	---	
						Eastern white pine	---	
						Yellow birch	---	
East Lake	3s	Slight	Slight	Severe	Slight	Sugar maple	53	Red pine, white spruce, jack pine.
						Northern red oak	---	
						Quaking aspen	---	
						Red pine	55	
						Jack pine	---	
						Paper birch	---	
36B, 36C Kalkaska	1s	Slight	Moderate	Severe	Slight	Sugar maple	72	Eastern white pine.
						Northern red oak	80	
						American beech	---	
						White ash	76	
						Black cherry	74	
						American basswood	---	
						Eastern white pine	75	
36E Kalkaska	1r	Moderate	Moderate	Severe	Slight	Sugar maple	72	Eastern white pine.
						Northern red oak	80	
						American beech	---	
						White ash	76	
						Black cherry	74	
						American basswood	---	
						Eastern white pine	75	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
10A*: Au Gres	---	Silky dogwood, American cranberrybush, Amur maple, nannyberry viburnum.	White spruce, northern white-cedar, Manchurian crabapple.	Norway spruce, green ash, eastern white pine, common ninebark.	Carolina poplar.
Finch	---	Silky dogwood, American cranberrybush, common ninebark, nannyberry viburnum, Amur maple.	White spruce, Norway spruce, northern white-cedar, eastern white pine, jack pine, Siberian crabapple.	Green ash	---
11A Croswell	---	Lilac, silky dogwood, arrowwood, white spruce, Amur privet, Siberian crabapple, Tatarian honeysuckle.	Austrian pine, eastern redcedar.	Red pine, eastern white pine.	Carolina poplar.
12B*, 12C*, 12D*, 12E*: Emmet	---	Arrowwood, lilac, Siberian crabapple, Tatarian honeysuckle, Amur privet.	White spruce, eastern redcedar.	Red pine, Norway spruce, eastern white pine, Austrian pine.	Carolina poplar.
Montcalm	---	Amur maple, Siberian peashrub, lilac, silky dogwood, Amur privet.	White spruce, Siberian crabapple, northern white-cedar.	Red pine, Norway spruce, eastern white pine, jack pine.	---
13B Grayling	Vanhoutte spirea	Lilac, Siberian peashrub, Amur privet, eastern redcedar, Tatarian honeysuckle.	Jack pine, eastern white pine, Austrian pine.	Red pine	---
14A Allendale	---	White spruce, American cranberrybush, silky dogwood, Tatarian honeysuckle, Amur privet, nannyberry viburnum, Roselow sargent crabapple.	Northern white-cedar, Manchurian crabapple.	Eastern white pine, Norway spruce.	Carolina poplar.
15B, 15C, 15E Kalkaska	Manyflower cotoneaster.	Lilac, Amur maple, Amur privet, Siberian peashrub, Siberian crabapple, silky dogwood.	Eastern redcedar	Red pine, eastern white pine, Austrian pine.	Carolina poplar.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
16B*:					
Hodenpyl	Siberian peashrub	Autumn-olive, Tatarian honeysuckle, Manchurian crabapple.	White spruce, northern white-cedar, Austrian pine, eastern redcedar.	Red pine, Norway spruce, eastern white pine.	Carolina poplar.
Karlin	---	Siberian crabapple, arrowwood, lilac, Amur privet, Tatarian honeysuckle, American cranberrybush.	Eastern redcedar	Red pine, Austrian pine, eastern white pine, Norway spruce.	Carolina poplar.
17A Kawkawlin	Vanhoutte spirea	White spruce, Roselow sargent crabapple, silky dogwood, Amur maple, lilac, American cranberrybush, nannyberry viburnum, northern white-cedar.	---	Red pine, Norway spruce, eastern white pine.	---
18. Loxley					
19. Lupton					
20B*, 20C*, 20E*:					
Montcalm	---	Amur maple, Siberian peashrub, lilac, silky dogwood, Amur privet.	White spruce, Siberian crabapple, northern white-cedar.	Red pine, Norway spruce, eastern white pine, jack pine.	---
Graycalm	Vanhoutte spirea, manyflower cotoneaster.	Siberian peashrub, lilac, Amur privet, Amur maple.	Eastern redcedar, Siberian crabapple.	Red pine, Austrian pine, eastern white pine.	Carolina poplar.
21B, 21C, 21E Nester	---	Arrowwood, lilac, Tatarian honeysuckle, white spruce, Amur privet, silky dogwood.	Blue spruce	Red pine, green ash, Austrian pine, eastern white pine.	Carolina poplar.
22*:					
Tawas.					
Roscommon.					
23B, 23E, 24D Rubicon	Vanhoutte spirea, manyflower cotoneaster.	Eastern redcedar, Amur privet, lilac, Washington hawthorn, Siberian peashrub, Amur maple.	Austrian pine	Red pine, eastern white pine, jack pine.	---
25*. Pits					

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
26B*:					
Manistee----------	---	Siberian crabapple, silky dogwood, Tatarian honeysuckle, lilac, Amur privet, American cranberrybush.	White spruce, eastern redcedar.	Red pine, Norway spruce, Austrian pine, eastern white pine.	---
Montcalm----------	---	Amur maple, Siberian peashrub, lilac, silky dogwood, Amur privet.	White spruce, Siberian crabapple, northern white-cedar.	Red pine, Norway spruce, eastern white pine, jack pine.	---
26C*:					
Manistee----------	---	Siberian crabapple, silky dogwood, Tatarian honeysuckle, lilac, Amur privet, American cranberrybush.	White spruce, eastern redcedar.	Red pine, Norway spruce, Austrian pine, eastern white pine.	---
Montcalm----------	---	Amur maple, Siberian peashrub, lilac, silky dogwood, Amur privet.	White spruce, Siberian crabapple, northern white-cedar.	Red pine, Norway spruce, eastern white pine, jack pine.	---
28C--------------- Dighton	---	Silky dogwood, Amur maple, lilac, Amur privet, Siberian peashrub.	Black Hills spruce, Siberian crabapple, northern white-cedar.	Green ash, Norway spruce, red pine, eastern white pine.	---
29B*, 29D*:					
Graycalm----------	Vanhoutte spirea, manyflower cotoneaster.	Siberian peashrub, lilac, Amur privet, Amur maple.	Eastern redcedar, Siberian crabapple.	Red pine, Austrian pine, eastern white pine.	Carolina poplar.
Grayling----------	Vanhoutte spirea	Lilac, Siberian peashrub, Amur privet, eastern redcedar, Tatarian honeysuckle.	Jack pine, eastern white pine, Austrian pine.	Red pine----------	---
30B*, 30C*, 30E*:					
Kalkaska----------	Manyflower cotoneaster.	Lilac, Amur maple, Amur privet, Siberian peashrub, Siberian crabapple, silky dogwood.	Eastern redcedar	Red pine, eastern white pine, Austrian pine.	Carolina poplar.
East Lake---------	---	Siberian peashrub, lilac, Tatarian honeysuckle, Amur privet.	Eastern redcedar, Austrian pine, Siberian crabapple.	Red pine----------	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
34----------------- Winterfield	---	Amur maple, Amur privet, silky dogwood, American cranberrybush, lilac, nannyberry viburnum.	White spruce, black spruce, northern white-cedar.	Eastern white pine, green ash.	Carolina poplar.
35B*:					
Mancelona---------	Vanhoutte spirea	Lilac, Tatarian honeysuckle, Siberian peashrub, Amur privet.	Manchurian crabapple, eastern redcedar.	Red pine, Austrian pine, eastern white pine, Norway spruce.	Carolina poplar.
East Lake---------	---	Siberian peashrub, lilac, Tatarian honeysuckle, Amur privet.	Eastern redcedar, Austrian pine, Siberian crabapple.	Red pine-----------	---
36B, 36C, 36E------ Kalkaska	Manyflower cotoneaster.	Amur maple, silky dogwood, Amur privet, lilac, Siberian crabapple.	Eastern redcedar	Austrian pine, red pine, eastern white pine.	Carolina poplar.
37*:					
Fluvaquents.					
Histosols.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
10A*:					
Au Gres	Severe: wetness, too sandy.	Severe: wetness, too sandy.	Severe: too sandy, wetness.	Severe: wetness, too sandy.	Severe: wetness.
Finch	Severe: wetness, too sandy, cemented pan.	Severe: wetness, too sandy, cemented pan.	Severe: too sandy, wetness, cemented pan.	Severe: wetness, too sandy.	Severe: wetness, droughty, thin layer.
11A Croswell	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty, too sandy.
12B*:					
Emmet	Slight	Slight	Moderate: slope.	Slight	Slight.
Montcalm	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
12C*:					
Emmet	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Montcalm	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
12D*:					
Emmet	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Montcalm	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
12E*:					
Emmet	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Montcalm	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
13B Grayling	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
14A Allendale	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Severe: wetness.
15B Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
15C Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
15E Kalkaska	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.	Severe: droughty, slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
16B*:					
Hodenpyl	Slight	Slight	Moderate: slope.	Slight	Slight.
Karlin	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
17A Kawkawlin	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
18 Loxley	Severe: ponding, excess humus, too acid.	Severe: ponding, excess humus, too acid.	Severe: excess humus, ponding, too acid.	Severe: ponding, excess humus.	Severe: too acid, ponding, excess humus.
19 Lupton	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
20B*:					
Montcalm	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
20C*:					
Montcalm	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
20E*:					
Montcalm	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Graycalm	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
21B Nester	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
21C Nester	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
21E Nester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
22*:					
Tawas	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
Roscommon	Severe: ponding, too sandy.	Severe: ponding, too sandy.	Severe: too sandy, ponding.	Severe: ponding, too sandy.	Severe: ponding.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
23B: Rubicon	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
23E, 24D: Rubicon	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
25*. Pits					
26B*:					
Manistee	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Moderate: droughty.
Montcalm	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
26C*:					
Manistee	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: droughty, slope.
Montcalm	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
28C: Dighton	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
29B*:					
Graycalm	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
Grayling	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
29D*:					
Graycalm	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
Grayling	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
30B*:					
Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
East Lake	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty, too sandy.
30C*:					
Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
East Lake	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Moderate: droughty, slope.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
30E*:					
Kalkaska	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty, slope.
East Lake	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: slope.
34 Winterfield	Severe: flooding, wetness, too sandy.	Severe: too sandy.	Severe: too sandy, wetness, flooding.	Severe: too sandy.	Severe: flooding.
35B*:					
Mancelona	Moderate: small stones.	Moderate: small stones.	Severe: small stones.	Slight	Moderate: small stones, droughty.
East Lake	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty, too sandy.
36B Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: droughty.
36C Kalkaska	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: droughty.
36E Kalkaska	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: slope, too sandy.	Severe: too sandy, slope.	Severe: droughty, slope.
37*:					
Fluvaquents.					
Histosols.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
10A*:										
Au Gres	Poor	Poor	Fair	Good	Good	Poor	Very poor.	Poor	Good	Very poor.
Finch	Poor	Poor	Fair	Fair	Fair	Poor	Poor	Poor	Fair	Poor.
11A Croswell	Poor	Poor	Fair	Good	Good	Poor	Very poor.	Poor	Fair	Very poor.
12B*:										
Emmet	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Montcalm	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
12C*:										
Emmet	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Montcalm	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
12D*:										
Emmet	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Montcalm	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
12E*:										
Emmet	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Montcalm	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
13B Grayling	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Very poor.
14A Allendale	Poor	Poor	Good	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
15B, 15C Kalkaska	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
15E Kalkaska	Very poor.	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
16B*:										
Hodenpyl	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Karlin	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
17A Kawkawlin	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
18 Loxley	Very poor.	Poor	Poor	Very poor.	Very poor.	Good	Good	Poor	Very poor.	Good.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hardwood trees	Conif- erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
19----------------- Lupton	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
20B*, 20C*:										
Montcalm----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Graycalm----------	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
20E*:										
Montcalm----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Graycalm----------	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
21B---------------- Nester	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
21C---------------- Nester	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
21E---------------- Nester	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
22*:										
Tawas-------------	Very poor.	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Roscommon---------	Very poor.	Poor	Poor	Fair	Fair	Good	Good	Poor	Fair	Good.
23B---------------- Rubicon	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
23E, 24D----------- Rubicon	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
25*. Pits										
26B*:										
Manistee----------	Poor	Poor	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Montcalm.										
26C*:										
Manistee----------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Montcalm.										
28C---------------- Dighton	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
29B*:										
Graycalm----------	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
Grayling----------	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
29D*:										
Graycalm----------	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hardwood trees	Conif- erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
29D*:										
Grayling	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
30B*:										
Kalkaska	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
East Lake	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
30C*:										
Kalkaska	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
East Lake	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
30E*:										
Kalkaska	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
East Lake	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
34 Winterfield	Poor	Poor	Fair	Fair	Fair	Poor	Fair	Fair	Fair	Poor.
35B*:										
Mancelona	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
East Lake	Poor	Poor	Fair	Fair	Fair	Poor	Very poor.	Poor	Fair	Very poor.
36B Kalkaska	Poor	Poor	Fair	Good	Good	Poor	Very poor.	Poor	Fair	Very poor.
36C Kalkaska	Poor	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
36E Kalkaska	Very poor.	Poor	Fair	Good	Good	Very poor.	Very poor.	Poor	Fair	Very poor.
37*:										
Fluvaquents.										
Histosols.										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
10A*:						
Au Gres	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Finch	Severe: cemented pan, cutbanks cave, wetness.	Severe: wetness.	Severe: wetness, cemented pan.	Severe: wetness.	Severe: wetness.	Severe: wetness, droughty, thin layer.
11A Croswell	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: droughty, too sandy.
12B*:						
Emmet	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
Montcalm	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
12C*:						
Emmet	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Montcalm	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
12D*, 12E*:						
Emmet	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Montcalm	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
13B Grayling	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
14A Allendale	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness.	Severe: wetness.
15B Kalkaska	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Severe: droughty.
15C Kalkaska	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
15E Kalkaska	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
16B*:						
Hodenpyl	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action.	Slight.
Karlin	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
17A Kawkawlin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
18---------------- Loxley	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: too acid, ponding, excess humus.
19---------------- Lupton	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
20B*:						
Montcalm---------	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
Graycalm---------	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Severe: droughty.
20C*:						
Montcalm---------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Graycalm---------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
20E*:						
Montcalm---------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Graycalm---------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
21B--------------- Nester	Moderate: too clayey, dense layer.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
21C--------------- Nester	Moderate: too clayey, dense layer, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
21E--------------- Nester	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
22*:						
Tawas------------	Severe: cutbanks cave, excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, frost action.	Severe: ponding, excess humus.
Roscommon--------	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
23B--------------- Rubicon	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Severe: droughty.
23E, 24D---------- Rubicon	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
25*. Pits						
26B*:						
Manistee---------	Severe: cutbanks cave.	Slight---------	Severe: shrink-swell.	Slight---------	Slight---------	Moderate: droughty.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
26B*:						
Montcalm----------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: droughty.
26C*:						
Manistee----------	Severe: cutbanks cave.	Moderate: slope.	Severe: shrink-swell.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Montcalm----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
28C---------------- Dighton	Severe: cutbanks cave.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
29B*:						
Graycalm----------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Severe: droughty.
Grayling----------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Severe: droughty.
29D*:						
Graycalm----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
Grayling----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
30B*:						
Kalkaska----------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Severe: droughty.
East Lake---------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: droughty, too sandy.
30C*:						
Kalkaska----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
East Lake---------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
30E*:						
Kalkaska----------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
East Lake---------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
34---------------- Winterfield	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding.	Severe: flooding.
35B*:						
Mancelona---------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: small stones, droughty.
East Lake---------	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: droughty, too sandy.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
36B---------------- Kalkaska	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Severe: droughty.
36C---------------- Kalkaska	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: droughty.
36E---------------- Kalkaska	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
37*:						
Fluvaquents.						
Histosols.						

See description of the map unit for composition and behavior of the map unit.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
10A*:					
Au Gres	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Finch	Severe: cemented pan, wetness, percs slowly.	Severe: seepage, cemented pan, wetness.	Severe: seepage, wetness, too sandy.	Severe: cemented pan, seepage, wetness.	Poor: area reclaim, seepage, too sandy.
11A Croswell	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
12B*:					
Emmet	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
Montcalm	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
12C*:					
Emmet	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope.
Montcalm	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
12D*, 12E*:					
Emmet	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Montcalm	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
13B Grayling	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
14A Allendale	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness, too clayey.	Severe: seepage, wetness.	Poor: too clayey, hard to pack, wetness.
15B Kalkaska	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
15C Kalkaska	Severe:** poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

See footnotes at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
15E----------------- Kalkaska	Severe:** poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
16B*:					
Hodenpyl-----------	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Slight-----------	Fair: thin layer.
Karlin-------------	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
17A----------------- Kawkawlin	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
18------------------ Loxley	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus, too acid.
19------------------ Lupton	Severe: ponding, percs slowly.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: seepage, ponding.	Poor: ponding, excess humus.
20B*:					
Montcalm-----------	Slight-----------	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Graycalm-----------	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
20C*:					
Montcalm-----------	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Graycalm-----------	Severe:** poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
20E*:					
Montcalm-----------	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Graycalm-----------	Severe:** poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
21B----------------- Nester	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
21C----------------- Nester	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
21E----------------- Nester	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnotes at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
22*:					
Tawas	Severe: ponding, percs slowly, poor filter.	Severe: seepage, excess humus, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
Roscommon	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
23B Rubicon	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
23E, 24D Rubicon	Severe:** poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
25*. Pits					
26B*:					
Manistee	Severe: percs slowly.	Severe: seepage.	Severe: too clayey.	Severe: seepage.	Poor: too clayey, hard to pack.
Montcalm	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
26C*:					
Manistee	Severe: percs slowly.	Severe: seepage, slope.	Severe: too clayey.	Severe: seepage.	Poor: too clayey, hard to pack.
Montcalm	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
28C Dighton	Severe:** percs slowly, poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
29B*:					
Graycalm	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Grayling	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
29D*:					
Graycalm	Severe:** poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
Grayling	Severe:** poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.

See footnotes at end of table.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
30B*:					
Kalkaska	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
East Lake	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
30C*:					
Kalkaska	Severe:** poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
East Lake	Severe:** poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
30E*:					
Kalkaska	Severe:** poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
East Lake	Severe:** poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
34 Winterfield	Severe: flooding, wetness, poor filter.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
35B*:					
Mancelona	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
East Lake	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
36B Kalkaska	Severe:** poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
36C Kalkaska	Severe:** poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
36E Kalkaska	Severe:** poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, slope.
37*:					
Fluvaquents.					
Histosols.					

* See description of the map unit for composition and behavior characteristics of the map unit.
** The effluent drains satisfactorily, but there is a danger of ground water pollution.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
10A*:				
Au Gres	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
Finch	Poor: wetness.	Probable	Improbable: too sandy.	Poor: area reclaim, too sandy, wetness.
11A Croswell	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
12B*:				
Emmet	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Montcalm	Good	Probable	Improbable: too sandy.	Poor: thin layer.
12C*:				
Emmet	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
Montcalm	Good	Probable	Improbable: too sandy.	Poor: thin layer.
12D*:				
Emmet	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Montcalm	Fair: slope.	Probable	Improbable: too sandy.	Poor: thin layer, slope.
12E*:				
Emmet	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Montcalm	Poor: slope.	Probable	Improbable: too sandy.	Poor: thin layer, slope.
13B Grayling	Good	Probable	Improbable: too sandy.	Poor: too sandy.
14A Allendale	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
15B, 15C Kalkaska	Good	Probable	Improbable: too sandy.	Poor: too sandy.
15E Kalkaska	Poor: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
16B*:				
Hodenpyl	Good	Probable	Improbable: too sandy.	Fair: area reclaim.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
16B*: Karlin	Good	Probable	Improbable: too sandy.	Fair: too sandy, small stones.
17A Kawkawlin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
18 Loxley	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness, too acid.
19 Lupton	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: excess humus, wetness.
20B*, 20C*: Montcalm	Good	Probable	Improbable: too sandy.	Poor: thin layer.
Graycalm	Good	Probable	Improbable: too sandy.	Poor: too sandy.
20E*: Montcalm	Fair: slope.	Probable	Improbable: too sandy.	Poor: thin layer, slope.
Graycalm	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
21B, 21C Nester	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
21E Nester	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, slope.
22*: Tawas	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
Roscommon	Poor: wetness.	Probable	Improbable: too sandy.	Poor: too sandy, wetness.
23B Rubicon	Good	Probable	Improbable: too sandy.	Poor: too sandy.
23E, 24D Rubicon	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
25*. Pits				
26B*: Manistee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy.
Montcalm	Good	Probable	Improbable: too sandy.	Poor: thin layer.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
26C*:				
Manistee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, too sandy.
Montcalm	Good	Probable	Improbable: too sandy.	Poor: thin layer.
28C Dighton	Good	Probable	Probable	Poor: area reclaim.
29B*:				
Graycalm	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Grayling	Good	Probable	Improbable: too sandy.	Poor: too sandy.
29D*:				
Graycalm	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
Grayling	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
30B*, 30C*:				
Kalkaska	Good	Probable	Improbable: too sandy.	Poor: too sandy.
East Lake	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
30E*:				
Kalkaska	Fair: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
East Lake	Fair: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
34 Winterfield	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too sandy.
35B*:				
Mancelona	Good	Probable	Probable	Poor: small stones, area reclaim.
East Lake	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
36B, 36C Kalkaska	Good	Probable	Improbable: too sandy.	Poor: too sandy.
36E Kalkaska	Poor: slope.	Probable	Improbable: too sandy.	Poor: too sandy, slope.
37*: Fluvaquents.				

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
37*:				
Histosols.				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Grassed waterways
10A*:						
Au Gres	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Wetness, droughty.
Finch	Severe: seepage, cemented pan.	Severe: seepage, piping, wetness.	Severe: no water.	Percs slowly, cemented pan.	Wetness, droughty, fast intake.	Wetness, droughty, cemented pan.
11A Croswell	Severe: seepage.	Severe: seepage.	Severe: cutbanks cave.	Cutbanks cave	Wetness, droughty, fast intake.	Droughty.
12B*:						
Emmet	Severe: seepage.	Moderate: seepage.	Severe: no water.	Deep to water	Soil blowing, slope.	Favorable.
Montcalm	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
12C*, 12D*, 12E*:						
Emmet	Severe: seepage, slope.	Moderate: seepage.	Severe: no water.	Deep to water	Soil blowing, slope.	Slope.
Montcalm	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
13B Grayling	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
14A Allendale	Severe: seepage.	Severe: hard to pack, wetness.	Severe: slow refill, cutbanks cave.	Percs slowly	Wetness, droughty, fast intake.	Wetness, droughty.
15B Kalkaska	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
15C, 15E Kalkaska	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
16B*:						
Hodenpyl	Moderate: seepage.	Severe: piping.	Severe: no water.	Deep to water	Soil blowing	Favorable.
Karlin	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
17A Kawkawlin	Slight	Severe: wetness.	Severe: slow refill.	Frost action	Wetness	Wetness.
18 Loxley	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, too acid.	Not needed.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Grassed waterways
19 Lupton	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
20B*:						
Montcalm	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
Graycalm	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
20C*, 20E*:						
Montcalm	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
Graycalm	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
21B Nester	Moderate: slope.	Slight	Severe: no water.	Deep to water	Slope	Favorable.
21C, 21E Nester	Severe: slope.	Slight	Severe: no water.	Deep to water	Slope	Slope.
22*:						
Tawas	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: slow refill, cutbanks cave.	Ponding, subsides, frost action.	Ponding, soil blowing.	Wetness.
Roscommon	Severe: seepage.	Severe: seepage, piping, ponding.	Severe: cutbanks cave.	Ponding, cutbanks cave.	Ponding, droughty, fast intake.	Wetness, droughty.
23B Rubicon	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
23E, 24D Rubicon	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
25*. Pits						
26B*:						
Manistee	Severe: seepage.	Severe: hard to pack.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty, percs slowly.
Montcalm	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
26C*:						
Manistee	Severe: seepage, slope.	Severe: hard to pack.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty, percs slowly.
Montcalm	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Grassed waterways
28C---------------- Dighton	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Favorable-------	Slope.
29B*: Graycalm----------	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
Grayling----------	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
29D*: Graycalm----------	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
Grayling----------	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
30B*: Kalkaska----------	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
East Lake---------	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
30C*, 30E*: Kalkaska----------	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
East Lake---------	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
34----------------- Winterfield	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Flooding, cutbanks cave.	Wetness, droughty, fast intake.	Wetness, droughty.
35B*: Mancelona---------	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
East Lake---------	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
36B---------------- Kalkaska	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Droughty.
36C, 36E----------- Kalkaska	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, soil blowing.	Slope, droughty.
37*: Fluvaquents.						
Histosols.						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
10A*:											
Au Gres----------	0-11	Sand--------------	SP, SM	A-2-4, A-3	0	95-100	85-100	50-70	0-15	---	NP**
	11-38	Sand, loamy sand	SP-SM, SP, SM	A-2-4, A-3	0	95-100	85-100	60-80	0-15	---	NP
	38-60	Sand--------------	SP, SP-SM	A-3, A-2-4	0	95-100	85-100	50-90	0-10	---	NP
Finch------------	0-20	Sand--------------	SP-SM, SM	A-3, A-2-4	0	100	100	50-70	5-15	---	NP
	20-28	Sand--------------	SP-SM, SM	A-3, A-2-4	0	100	100	80-95	5-15	---	NP
	28-60	Sand--------------	SP, SP-SM	A-3	0	100	100	80-95	0-10	---	NP
11A--------------- Croswell	0-15	Sand--------------	SP-SM, SM	A-3, A-2-4	0	90-100	85-100	50-70	5-25	---	NP
	15-38	Sand, loamy sand	SP-SM, SM	A-3, A-2-4	0	90-100	85-100	50-70	5-25	---	NP
	38-60	Sand--------------	SP-SM, SM	A-3, A-2-4	0	90-100	85-100	50-70	5-25	---	NP
12B*, 12C*, 12D*, 12E*:											
Emmet-----------	0-8	Sandy loam--------	SM, SM-SC, SC	A-2	0-5	95-100	95-100	55-70	25-35	10-25	NP-10
	8-23	Sandy loam, loamy sand, fine sandy loam.	SM, SM-SC, SC	A-2	0-5	95-100	90-100	55-70	15-35	10-25	NP-10
	23-38	Loam, sandy loam, sandy clay loam.	SM-SC, CL, CL-ML, SC	A-2, A-4, A-6	0-5	95-100	90-100	55-85	25-75	20-40	5-20
	38-60	Fine loamy sand, sandy loam.	SM, SM-SC, SC	A-2	0-5	85-95	80-90	50-70	25-35	<25	NP-10
Montcalm--------	0-7	Loamy sand--------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	7-42	Loamy sand, sand	SM	A-2	0-2	95-100	85-100	50-75	15-30	---	NP
	42-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	80-100	50-80	10-35	---	NP
13B--------------- Grayling	0-16	Sand--------------	SM, SP-SM	A-1, A-2, A-3	0	100	90-100	35-65	5-15	---	NP
	16-60	Sand, coarse sand	SP, SP-SM	A-1, A-3, A-2	0	100	90-100	40-55	0-10	---	NP
14A--------------- Allendale	0-23	Loamy sand--------	SM	A-2-4	0	100	95-100	50-75	15-25	---	NP
	23-27	Sand, loamy sand, loamy fine sand.	SP, SM, SP-SM	A-2-4, A-3	0	100	95-100	50-70	0-20	---	NP
	27-60	Silty clay, clay, clay loam.	CH, MH	A-7	0	100	90-100	90-100	75-95	50-70	20-40
15B, 15C, 15E----- Kalkaska	0-12	Sand--------------	SM, SP-SM	A-1, A-2, A-3	0	100	95-100	40-70	5-15	---	NP
	12-48	Sand--------------	SM, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-75	5-15	---	NP
	48-60	Sand--------------	SP, SP-SM	A-1, A-2, A-3	0	100	95-100	40-80	0-10	---	NP
16B*:											
Hodenpyl---------	0-10	Sandy loam--------	SM, SM-SC, SC	A-2-4, A-4	0	95-100	95-100	55-95	25-50	<25	2-8
	10-41	Sandy loam, fine sandy loam, loam.	ML, CL, SM, SC	A-4	0	95-100	95-100	60-90	35-75	<25	2-10
	41-60	Loamy sand, sand	SM, SP-SM	A-2-4, A-3	0-15	90-100	80-100	50-90	5-30	<20	NP-4
Karlin-----------	0-29	Loamy fine sand, loamy sand.	SM	A-2	0	90-100	85-100	50-75	20-35	---	NP-4
	29-60	Sand--------------	SP-SM	A-3, A-1, A-2	0	80-100	70-100	40-70	5-10	---	NP

See footnotes at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
17A-------------- Kawkawlin	0-7	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	80-100	55-85	25-40	2-15
	7-24	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0-5	95-100	90-100	85-100	60-90	25-55	11-30
	24-60	Clay loam, silty clay loam.	CL	A-6	0-5	95-100	90-100	85-100	60-90	25-36	11-18
18-------------- Loxley	0-4	Fibric material	PT	A-8	0	---	---	---	---	---	---
	4-60	Sapric material, hemic material.	PT	A-8	0	---	---	---	---	---	---
19-------------- Lupton	0-60	Sapric material	PT	A-8	---	---	---	---	---	---	---
20B*, 20C*, 20E*:											
Montcalm--------	0-7	Loamy sand-------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	7-42	Loamy sand, sand	SM	A-2	0-2	95-100	85-100	50-75	15-30	---	NP
	42-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	80-100	50-80	10-35	---	NP
Graycalm--------	0-2	Sand-------------	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-70	5-15	---	NP
	2-28	Sand, loamy sand	SP-SM, SM	A-3, A-2, A-1	0	95-100	75-100	40-75	5-20	---	NP
	28-60	Sand, loamy sand, loamy coarse sand.	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	5-20	---	NP
21B, 21C, 21E---- Nester	0-11	Sandy loam, loam	SM, SC, ML, CL	A-2, A-4	0-5	90-100	85-100	60-100	25-60	<25	NP-10
	11-28	Clay loam, silty clay loam, sandy loam.	CL, CH, SC	A-6, A-7	0-5	95-100	95-100	65-100	35-90	35-60	15-30
	28-60	Clay loam, sandy clay loam.	CL	A-6, A-7	0-5	95-100	95-100	85-100	50-90	30-45	10-20
22*:											
Tawas-----------	0-41	Sapric material	PT	A-8	0	---	---	---	---	---	---
	41-60	Fine sand, sand, loamy sand.	SP, SM, SP-SM	A-3, A-2-4	0	80-100	60-100	50-75	0-20	---	NP
Roscommon-------	0-9	Mucky sand-------	SM, SP, SP-SM	A-2, A-3, A-1	0	100	90-100	40-70	0-15	---	NP
	9-60	Sand, loamy sand, coarse sand.	SP, SP-SM, SM	A-1, A-2, A-3	0	95-100	85-100	40-70	0-15	---	NP
23B, 23E, 24D---- Rubicon	0-10	Sand-------------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	10-43	Sand-------------	SM, SP-SM	A-2, A-3	0	95-100	90-100	50-70	5-15	---	NP
	43-60	Sand-------------	SP, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-65	0-10	---	NP
25*. Pits											
26B*, 26C*:											
Manistee--------	0-4	Loamy sand-------	SM	A-2-4	0-2	95-100	95-100	50-75	15-30	---	NP
	4-31	Sand, loamy sand, fine sand.	SP-SM, SM	A-2-4	0-2	95-100	95-100	50-75	10-25	---	NP
	31-60	Clay, silty clay, silty clay loam.	CH	A-7	0	100	100	90-100	80-95	50-80	25-45
Montcalm--------	0-7	Loamy sand-------	SM	A-2	0-2	95-100	95-100	50-75	15-30	---	NP
	7-42	Loamy sand, sand	SM	A-2	0-2	95-100	85-100	50-75	15-30	---	NP
	42-60	Stratified sand to sandy loam.	SM, SP-SM	A-2	0-2	90-100	80-100	50-80	10-35	---	NP

See footnotes at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
28C--------------- Dighton	0-8	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	95-100	85-100	60-80	20-35	3-18
	8-31	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	95-100	90-100	70-95	35-70	15-42
	31-60	Sand, sandy loam, gravelly sand.	SP, SM, SP-SM	A-3, A-1, A-2	0	70-100	45-100	15-70	2-35	<20	NP
29B*, 29D*: Graycalm---------	0-2	Sand-------------	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-70	5-15	---	NP
	2-28	Sand, loamy sand	SP-SM, SM	A-3, A-2, A-1	0	95-100	75-100	40-75	5-20	---	NP
	28-48	Sand, loamy sand, loamy coarse sand.	SM, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	5-20	---	NP
	48-60	Sand, coarse sand	SP, SP-SM	A-2, A-1, A-3	0	95-100	75-100	40-75	0-15	---	NP
Grayling---------	0-16	Sand-------------	SM, SP-SM	A-1, A-2, A-3	0	100	90-100	35-65	5-15	---	NP
	16-60	Sand, coarse sand	SP, SP-SM	A-1, A-3, A-2	0	100	90-100	40-55	0-10	---	NP
30B*, 30C*, 30E*: Kalkaska---------	0-12	Sand-------------	SM, SP-SM	A-1, A-2, A-3	0	100	95-100	40-70	5-15	---	NP
	12-48	Sand-------------	SM, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-75	5-15	---	NP
	48-60	Sand-------------	SP, SP-SM	A-1, A-2, A-3	0	100	95-100	40-80	0-10	---	NP
East Lake--------	0-4	Sand-------------	SM, SP-SM	A-1, A-2-4, A-3	0	95-100	80-100	40-70	5-15	---	NP
	4-21	Sand, loamy sand, gravelly sand.	SM, SP-SM	A-1, A-2-4, A-3	0	90-100	75-100	40-75	5-15	---	NP
	21-60	Gravelly sand, very gravelly sand, sand.	GP, SP-SM, SP, GP-GM	A-1, A-3, A-2-4	0	40-90	25-80	20-60	0-10	---	NP
34--------------- Winterfield	0-8	Sand-------------	SM, SP-SM	A-2-4, A-3	0	100	95-100	50-80	5-35	---	NP
	8-48	Sand, loamy sand, loamy fine sand.	SM, SP-SM	A-2-4, A-3, A-4	0	100	95-100	50-90	5-45	---	NP
	48-60	Sand, gravelly sand, loamy sand.	SM, SP-SM, SP	A-3, A-1-b, A-2-4	0	90-100	80-100	45-80	0-35	---	NP
35B*: Mancelona--------	0-7	Loamy sand, sand	SM	A-2, A-1-b	0-5	90-100	65-95	40-70	15-30	---	NP
	7-28	Loamy sand, sand, gravelly sand.	SM, SP-SM	A-2, A-1-b	0-5	90-100	65-95	40-60	10-30	---	NP
	28-34	Gravelly loamy sand, sandy clay loam, gravelly sandy loam.	SM, SM-SC, SC	A-2, A-4	0-5	85-100	60-95	60-70	30-45	12-30	NP-10
	34-60	Very gravelly sand, gravelly sand, coarse sand.	GP, SP, GW, SW	A-1	5-10	40-90	35-85	20-40	0-10	---	NP

See footnotes at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
35B*:											
East Lake--------	0-4	Sand--------------	SM, SP-SM	A-1, A-2-4, A-3	0	95-100	80-100	40-70	5-15	---	NP
	4-21	Sand, loamy sand, gravelly sand.	SM, SP-SM	A-1, A-2-4, A-3	0	90-100	75-100	40-75	5-15	---	NP
	21-60	Gravelly sand, very gravelly sand, sand.	GP, SP-SM, SP, GP-GM	A-1, A-3, A-2-4	0	40-90	25-80	20-60	0-10	---	NP
36B, 36C, 36E---- Kalkaska	0-12	Sand--------------	SM, SP-SM	A-1, A-2, A-3	0	100	95-100	40-70	5-15	---	NP
	12-48	Sand--------------	SM, SP-SM	A-1, A-2, A-3	0	95-100	90-100	40-75	5-15	---	NP
	48-60	Sand--------------	SP, SP-SM	A-1, A-2, A-3	0	100	95-100	40-80	0-10	---	NP
37*:											
Fluvaquents.											
Histosols.											

* See description of the map unit for composition and behavior characteristics of the map unit.
** NP means nonplastic.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH					Pct
10A*:											
Au Gres----------	0-11	0-8	0.65-1.55	6.0-20	0.07-0.10	4.5-7.3	Low-----------	0.15	5	1	.5-8
	11-38	1-15	1.20-1.55	6.0-20	0.06-0.09	4.5-7.3	Low-----------	0.15			
	38-60	0-8	1.20-1.65	6.0-20	0.05-0.07	5.1-7.3	Low-----------	0.15			
Finch-----------	0-20	0-8	0.40-1.40	6.0-20	0.07-0.09	4.5-7.3	Low-----------	0.15	4	1	2-7
	20-28	5-10	1.75-2.05	0.06-0.2	0.02-0.04	4.5-7.3	Low-----------	0.15			
	28-60	0-10	1.40-1.55	6.0-20	0.02-0.04	5.6-7.8	Low-----------	0.15			
11A--------------- Croswell	0-15	0-10	1.25-1.55	6.0-20	0.07-0.09	3.6-7.3	Low-----------	0.15	5	1	.5-2
	15-38	0-10	1.25-1.60	6.0-20	0.06-0.08	3.6-7.3	Low-----------	0.15			
	38-60	0-10	1.25-1.60	6.0-20	0.05-0.07	5.1-8.4	Low-----------	0.15			
12B*, 12C*, 12D*, 12E*:											
Emmet-----------	0-8	5-15	1.10-1.65	2.0-6.0	0.12-0.15	6.1-6.5	Low-----------	0.20	5	3	1-3
	8-23	10-18	1.20-1.70	2.0-6.0	0.11-0.14	6.1-6.5	Low-----------	0.20			
	23-38	15-25	1.30-2.00	0.6-2.0	0.11-0.18	6.6-7.8	Moderate------	0.32			
	38-60	8-18	1.20-1.65	2.0-6.0	0.08-0.12	7.4-8.4	Low-----------	0.32			
Montcalm--------	0-7	2-10	1.15-1.60	2.0-6.0	0.10-0.12	5.1-6.5	Low-----------	0.17	5	2	.5-3
	7-42	8-15	1.20-1.60	2.0-6.0	0.06-0.10	5.1-6.5	Low-----------	0.17			
	42-60	2-18	1.20-1.60	2.0-6.0	0.04-0.13	5.1-6.5	Low-----------	0.17			
13B--------------- Grayling	0-16	0-10	1.30-1.65	6.0-20	0.05-0.09	4.5-5.0	Low-----------	0.15	5	1	---
	16-60	0-10	1.45-1.65	6.0-20	0.04-0.06	4.5-6.5	Low-----------	0.15			
14A--------------- Allendale	0-23	0-12	1.25-1.40	2.0-20	0.09-0.12	5.1-7.3	Low-----------	0.17	4	2	1-3
	23-27	0-15	1.35-1.45	6.0-20	0.06-0.10	5.1-7.3	Low-----------	0.17			
	27-60	40-60	1.45-1.75	0.06-0.2	0.08-0.12	6.1-8.4	High----------	0.32			
15B, 15C, 15E---- Kalkaska	0-12	0-10	1.25-1.45	6.0-20	0.05-0.09	4.5-6.0	Low-----------	0.15	5	1	1-4
	12-48	0-10	1.35-1.45	6.0-20	0.06-0.08	4.5-6.0	Low-----------	0.15			
	48-60	0-10	1.35-1.45	6.0-20	0.04-0.06	5.1-6.5	Low-----------	0.15			
16B*:											
Hodenpyl---------	0-10	2-12	1.15-1.60	0.6-2.0	0.13-0.18	5.1-6.5	Low-----------	0.24	5	3	.5-2
	10-41	8-18	1.30-1.60	0.6-2.0	0.12-0.19	4.5-6.0	Low-----------	0.24			
	41-60	0-10	1.20-1.45	2.0-6.0	0.04-0.10	4.5-7.3	Low-----------	0.17			
Karlin-----------	0-29	0-12	1.35-1.60	2.0-6.0	0.08-0.12	4.5-6.5	Low-----------	0.17	4	2	.5-2
	29-60	0-10	1.40-1.70	6.0-20	0.02-0.04	5.6-6.5	Low-----------	0.17			
17A--------------- Kawkawlin	0-7	8-27	1.45-1.70	0.6-2.0	0.20-0.24	5.1-7.3	Low-----------	0.32	5	6	2-4
	7-24	35-45	1.45-1.60	0.2-0.6	0.10-0.20	5.1-7.8	Moderate------	0.32			
	24-60	30-40	1.50-1.60	0.2-0.6	0.13-0.20	7.9-8.4	Moderate------	0.32			
18---------------- Loxley	0-4	---	0.30-0.40	2.0-6.0	0.35-0.45	<4.5	--------------	----	2	5	70-90
	4-60	---	0.10-0.35	0.2-6.0	0.35-0.45	<4.5	--------------	----			
19---------------- Lupton	0-60	---	0.10-0.35	0.2-6.0	0.35-0.45	5.6-7.8	--------------	----	2	2	70-90
20B*, 20C*, 20E*:											
Montcalm---------	0-7	2-10	1.15-1.60	2.0-6.0	0.10-0.12	5.1-6.5	Low-----------	0.17	5	2	.5-3
	7-42	8-15	1.20-1.60	2.0-6.0	0.06-0.10	5.1-6.5	Low-----------	0.17			
	42-60	2-18	1.20-1.60	2.0-6.0	0.04-0.13	5.1-6.5	Low-----------	0.17			
Graycalm---------	0-2	0-10	1.30-1.55	6.0-20	0.04-0.10	4.5-6.5	Low-----------	0.15	5	1	.5-2
	2-28	0-15	1.25-1.60	6.0-20	0.05-0.10	4.5-6.5	Low-----------	0.15			
	28-60	0-10	1.50-1.65	6.0-20	0.04-0.09	4.5-6.5	Low-----------	0.15			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
21B, 21C, 21E----Nester	0-11	0-18	1.50-1.85	2.0-6.0	0.13-0.15	5.1-7.3	Low----------	0.24	5	3	1-3
	11-28	35-45	1.55-1.80	0.2-0.6	0.10-0.20	5.1-7.3	Moderate-----	0.32			
	28-60	35-45	1.65-1.95	0.2-0.6	0.14-0.20	7.9-8.4	Moderate-----	0.32			
22*:											
Tawas-----------	0-41	---	0.30-0.55	0.2-6.0	0.35-0.45	4.5-7.8	-------------	----	2	2	40-60
	41-60	0-10	1.40-1.65	6.0-20	0.03-0.10	5.6-8.4	Low----------	----			
Roscommon-------	0-9	0-10	0.90-1.60	6.0-20	0.06-0.18	5.6-7.8	Low----------	0.17	5	1	4-15
	9-60	0-10	1.45-1.75	6.0-20	0.05-0.07	5.6-8.4	Low----------	0.17			
23B, 23E, 24D----Rubicon	0-10	0-5	1.36-1.41	6.0-20	0.05-0.09	4.5-6.0	Low----------	0.15	5	1	---
	10-43	0-10	1.30-1.60	6.0-20	0.04-0.08	4.5-6.0	Low----------	0.15			
	43-60	0-5	1.40-1.55	6.0-20	0.04-0.06	4.5-6.5	Low----------	0.15			
25*. Pits											
26B*, 26C*:											
Manistee--------	0-4	3-12	1.15-1.60	6.0-20	0.10-0.12	5.1-7.3	Low----------	0.17	4	2	2-4
	4-31	2-12	1.25-1.60	6.0-20	0.06-0.10	5.1-7.3	Low----------	0.17			
	31-60	35-60	1.50-1.70	0.06-0.2	0.08-0.12	5.1-8.4	High---------	0.32			
Montcalm--------	0-7	2-10	1.15-1.60	2.0-6.0	0.10-0.12	5.1-6.5	Low----------	0.17	5	2	.5-3
	7-42	8-15	1.20-1.60	2.0-6.0	0.06-0.10	5.1-6.5	Low----------	0.17			
	42-60	2-18	1.20-1.60	2.0-6.0	0.04-0.13	5.1-6.5	Low----------	0.17			
28C--------------Dighton	0-8	18-30	1.50-1.80	0.6-2.0	0.16-0.22	5.1-6.5	Moderate-----	0.32	4	6	1-3
	8-31	35-45	1.55-1.80	0.2-0.6	0.11-0.20	5.1-6.5	Moderate-----	0.32			
	31-60	0-8	1.40-1.55	>6.0	0.02-0.07	5.6-8.4	Low----------	0.15			
29B*, 29D*:											
Graycalm--------	0-2	0-10	1.30-1.55	6.0-20	0.04-0.10	4.5-6.5	Low----------	0.15	5	1	.5-2
	2-28	0-15	1.25-1.60	6.0-20	0.05-0.10	4.5-6.5	Low----------	0.15			
	28-48	0-10	1.50-1.65	6.0-20	0.04-0.09	4.5-6.5	Low----------	0.15			
	48-60	0-10	1.50-1.65	6.0-20	0.04-0.06	5.1-8.4	Low----------	0.15			
Grayling--------	0-16	0-10	1.30-1.65	6.0-20	0.05-0.09	4.5-5.0	Low----------	0.15	5	1	---
	16-60	0-10	1.45-1.65	6.0-20	0.04-0.06	4.5-6.5	Low----------	0.15			
30B*, 30C*, 30E*:											
Kalkaska--------	0-12	0-10	1.25-1.45	6.0-20	0.05-0.09	4.5-6.0	Low----------	0.15	5	1	1-4
	12-48	0-10	1.35-1.45	6.0-20	0.06-0.08	4.5-6.0	Low----------	0.15			
	48-60	0-10	1.35-1.45	6.0-20	0.04-0.06	5.1-6.5	Low----------	0.15			
East Lake-------	0-4	0-8	1.30-1.60	6.0-20	0.05-0.09	5.6-7.3	Low----------	0.15	5	1	.5-2
	4-21	0-10	1.30-1.60	6.0-20	0.07-0.10	5.6-7.3	Low----------	0.15			
	21-60	0-10	1.50-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.15			
34---------------Winterfield	0-8	0-10	0.90-1.60	6.0-20	0.07-0.09	5.6-7.8	Low----------	0.17	5	1	---
	8-48	0-15	1.45-1.60	6.0-20	0.06-0.11	5.6-7.8	Low----------	0.17			
	48-60	0-10	1.55-1.65	6.0-20	0.04-0.10	5.6-8.4	Low----------	0.17			
35B*:											
Mancelona-------	0-7	0-10	1.15-1.60	2.0-6.0	0.10-0.12	5.6-7.3	Low----------	0.17	4	2	.5-3
	7-28	0-15	1.25-1.50	6.0-20	0.06-0.12	5.6-7.8	Low----------	0.17			
	28-34	10-25	1.25-1.60	2.0-6.0	0.06-0.16	6.1-7.8	Low----------	0.17			
	34-60	0-10	1.20-1.50	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
East Lake-------	0-4	0-8	1.30-1.60	6.0-20	0.05-0.09	5.6-7.3	Low----------	0.15	5	1	.5-2
	4-21	0-10	1.30-1.60	6.0-20	0.07-0.10	5.6-7.3	Low----------	0.15			
	21-60	0-10	1.50-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.15			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
								K	T		
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
36B, 36C, 36E---- Kalkaska	0-12	0-10	1.25-1.45	6.0-20	0.05-0.09	4.5-6.0	Low-----------	0.15	5	1	1-4
	12-48	0-10	1.35-1.45	6.0-20	0.06-0.08	4.5-6.0	Low-----------	0.15			
	48-60	0-10	1.35-1.45	6.0-20	0.04-0.06	5.1-6.5	Low-----------	0.15			
37*: Fluvaquents.											
Histosols.											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
10A*:										
Au Gres	B	None	---	---	0.5-1.5	Apparent	Nov-May	Moderate	Low	Moderate.
Finch	C	None	---	---	0.5-1.5	Perched	Dec-Jun	Moderate	High	Moderate.
11A Croswell	A	None	---	---	2.0-3.0	Apparent	Nov-Apr	Low	Low	Moderate.
12B*, 12C*, 12D*, 12E*:										
Emmet	B	None	---	---	>6.0	---	---	Moderate	Low	Moderate.
Montcalm	A	None	---	---	>6.0	---	---	Low	Low	Moderate.
13B Grayling	A	None	---	---	>6.0	---	---	Low	Low	Moderate.
14A Allendale	B	None	---	---	0.5-1.5	Perched	Nov-May	Moderate	High	Moderate.
15B, 15C, 15E Kalkaska	A	None	---	---	>6.0	---	---	Low	Low	High.
16B*:										
Hodenpyl	B	None	---	---	>6.0	---	---	Moderate	Low	Moderate.
Karlin	A	None	---	---	>6.0	---	---	Low	Low	High.
17A Kawkawlin	C	None	---	---	1.0-2.0	Apparent	Oct-May	High	High	Low.
18** Loxley	A/D	None	---	---	+1-1.0	Apparent	Nov-May	High	High	High.
19 Lupton	A/D	None	---	---	+1-1.0	Apparent	Sep-May	High	High	Low.
20B*, 20C*, 20E*:										
Montcalm	A	None	---	---	>6.0	---	---	Low	Low	Moderate.
Graycalm	A	None	---	---	>6.0	---	---	Low	Low	Moderate.
21B, 21C, 21E Nester	C	None	---	---	>6.0	---	---	Moderate	High	Low.
22*:										
Tawas	A/D	None	---	---	+1-1.0	Apparent	Nov-May	High	High	Moderate.
Roscommon	A/D	None	---	---	+1-1.0	Apparent	Sep-Jun	Moderate	High	Low.
23B, 23E, 24D Rubicon	A	None	---	---	>6.0	---	---	Low	Low	High.
25*. Pits										
26B*, 26C*:										
Manistee	A	None	---	---	>6.0	---	---	Low	High	Moderate.
Montcalm	A	None	---	---	>6.0	---	---	Low	Low	Moderate.
28C Dighton	B	None	---	---	>6.0	---	---	Moderate	High	Moderate.

See footnotes at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
29B*, 29D*:										
Graycalm----------	A	None---------	---	---	>6.0	---	---	Low------	Low-------	Moderate.
Grayling----------	A	None---------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.
30B*, 30C*, 30E*:										
Kalkaska----------	A	None---------	---	---	>6.0	---	---	Low-------	Low-------	High.
East Lake---------	A	None---------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.
34----------------- Winterfield	A/D	Frequent----	Brief------	Nov-May	1.0-2.0	Apparent	Nov-May	Moderate	Low-------	Low.
35B*:										
Mancelona---------	A	None---------	---	---	>6.0	---	---	Low-------	Low-------	Low.
East Lake---------	A	None---------	---	---	>6.0	---	---	Low-------	Low-------	Moderate.
36B, 36C, 36E----- Kalkaska	A	None---------	---	---	>6.0	---	---	Low-------	Low-------	High.
37*:										
Fluvaquents.										
Histosols.										

* See description of the map unit for composition and behavior characteristics of the map unit.
** A plus sign under "Depth to high water table" indicates that the water table is above the surface of the soil.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Allendale	Sandy over clayey, mixed, frigid Alfic Haplaquods
Au Gres	Sandy, mixed, frigid Entic Haplaquods
Croswell	Sandy, mixed, frigid Entic Haplorthods
Dighton	Clayey over sandy or sandy-skeletal, mixed Typic Eutroboralfs
East Lake	Sandy, mixed, frigid Entic Haplorthods
Emmet	Coarse-loamy, mixed Typic Eutroboralfs
Finch	Sandy, mixed, frigid, ortstein Aeric Haplaquods
Fluvaquents	Mixed, nonacid, frigid Fluvaquents
Graycalm	Mixed, frigid Alfic Udipsamments
Grayling	Mixed, frigid Typic Udipsamments
Histosols	Euic, frigid Histosols
Hodenpyl	Coarse-loamy, mixed Eutric Glossoboralfs
Kalkaska	Sandy, mixed, frigid Typic Haplorthods
Karlin	Sandy, mixed, frigid Entic Haplorthods
Kawkawlin	Fine, mixed Aquic Eutroboralfs
Loxley	Dysic Typic Borosaprists
Lupton	Euic Typic Borosaprists
Mancelona	Sandy, mixed, frigid Alfic Haplorthods
Manistee	Sandy over clayey, mixed, frigid Alfic Haplorthods
Montcalm	Coarse-loamy, mixed Eutric Glossoboralfs
Nester	Fine, mixed Typic Eutroboralfs
Roscommon	Mixed, frigid Mollic Psammaquents
Rubicon	Sandy, mixed, frigid Entic Haplorthods
Tawas	Sandy or sandy-skeletal, mixed, euic Terric Borosaprists
Winterfield	Mixed, frigid Aquic Udipsamments

☆ U.S. GOVERNMENT PRINTING OFFICE : 1985 O - 439-836

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

Nondiscrimination Statement

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for

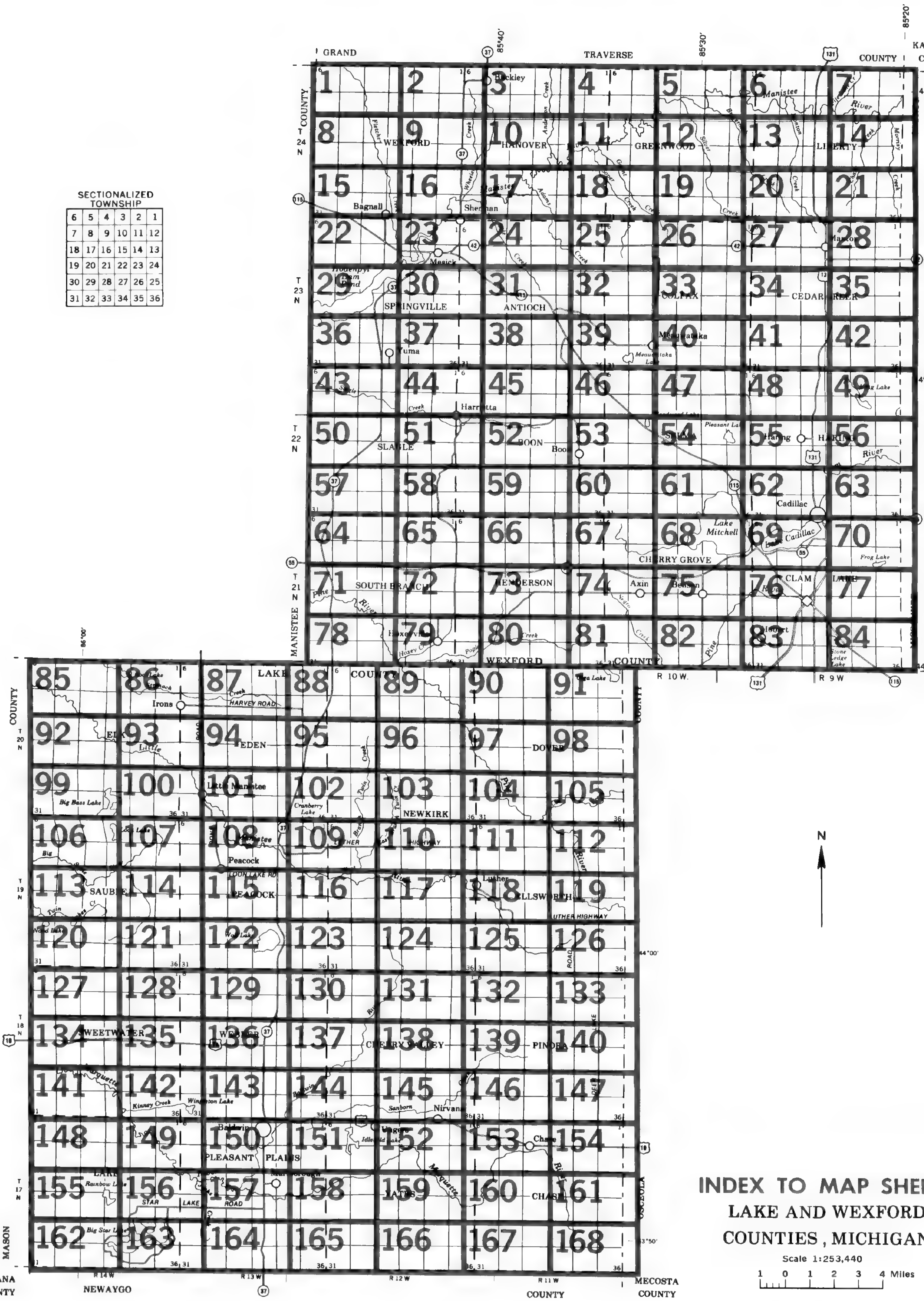
program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

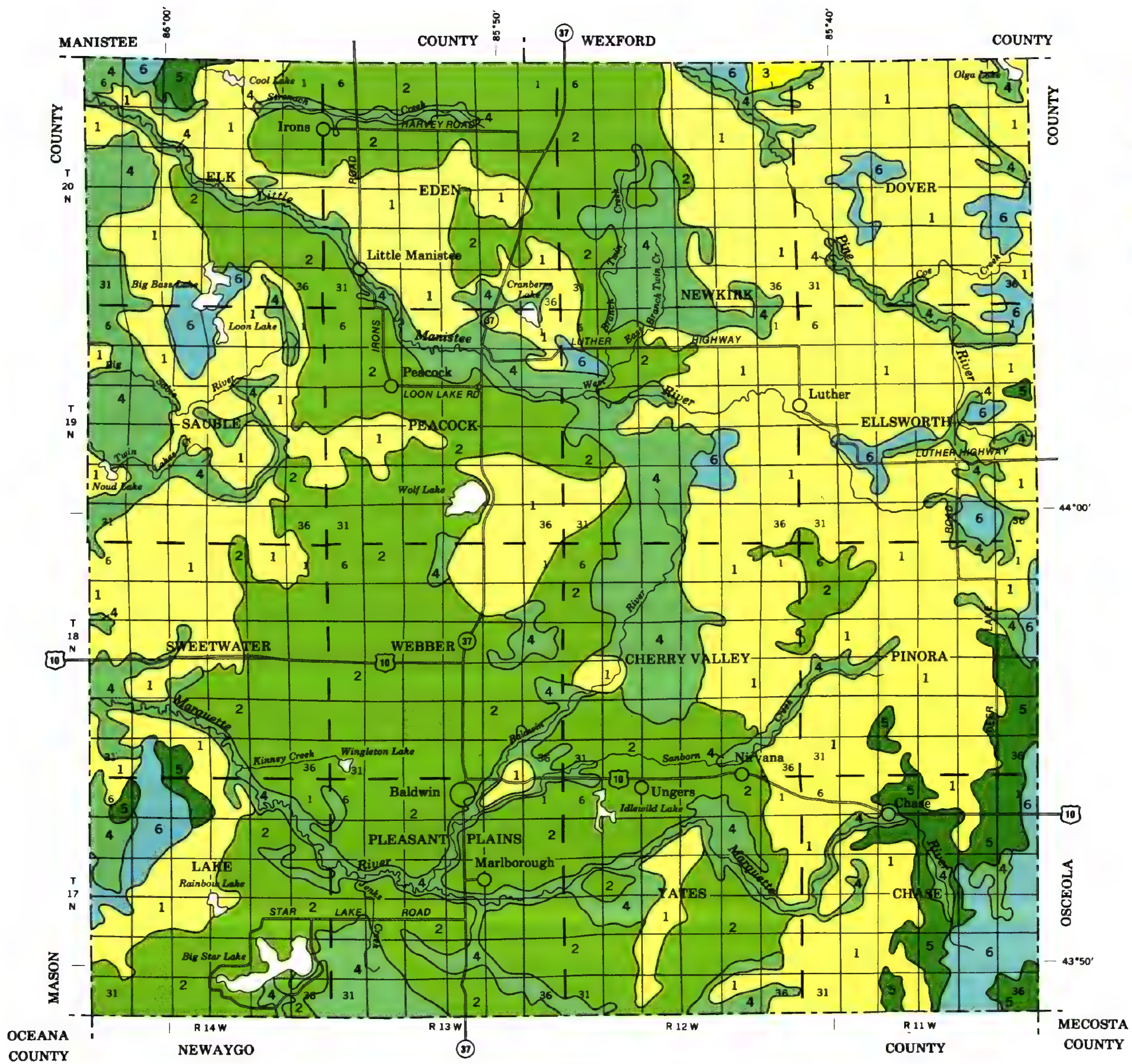
For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).



INDEX TO MAP SHEETS
LAKE AND WEXFORD COUNTIES, MICHIGAN



LEGEND*

1	RUBICON-MONTCALM-GRAYCALM: Nearly level to steep, somewhat excessively drained and well drained sandy soils on moraines, till plains, and outwash plains
2	GRAYLING-GRAYCALM: Nearly level to moderately steep, excessively drained and somewhat excessively drained sandy soils on outwash plains, till plains, and low moraines
3	KALKASKA: Nearly level to steep, somewhat excessively drained and well drained sandy soils on outwash plains, till plains, and moraines
4	TAWAS-CROSWELL-LUPTON: Nearly level and undulating, very poorly drained and moderately well drained mucky and sandy soils in bogs, depressions, and drainageways and on low flats and benches
5	EMMET-MONTCALM: Nearly level to steep, well drained loamy and sandy soils on till plains and moraines
6	NESTER-KAWKAWLIN-MANISTEE: Nearly level to steep, well drained and somewhat poorly drained loamy and sandy soils on till plains and moraines

*The texture given in the descriptive headings refers to the texture of the surface layer of the major soils in each association.

Compiled 1983

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FOREST SERVICE
MICHIGAN AGRICULTURAL EXPERIMENT STATION

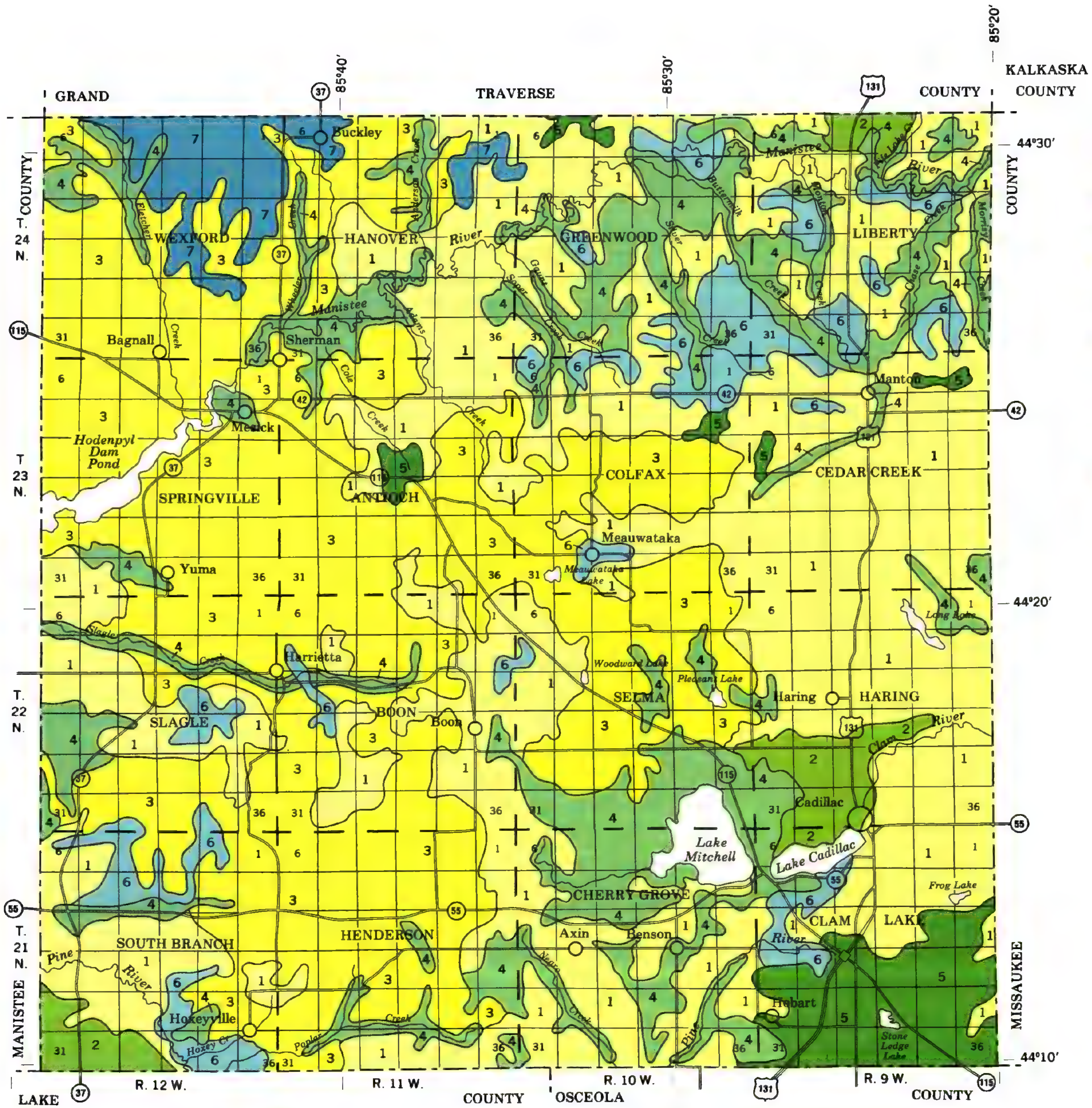
GENERAL SOIL MAP
LAKE COUNTY
MICHIGAN

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



LEGEND*

1	RUBICON-MONTCALM-GRAYCALM: Nearly level to steep, somewhat excessively drained and well drained sandy soils on moraines, till plains, and outwash plains
2	GRAYLING-GRAYCALM: Nearly level to moderately steep, excessively drained and somewhat excessively drained sandy soils on outwash plains, till plains, and low moraines
3	KALKASKA: Nearly level to steep, somewhat excessively drained and well drained sandy soils on outwash plains, till plains, and moraines
4	TAWAS-CROSWELL-LUPTON: Nearly level and undulating, very poorly drained and moderately well drained mucky and sandy soils in bogs, depressions, and drainageways and on low flats and benches
5	EMMET-MONTCALM: Nearly level to steep, well drained loamy and sandy soils on till plains and moraines
6	NESTER-KAWKAWLIN-MANISTEE: Nearly level to steep, well drained and somewhat poorly drained loamy and sandy soils on till plains and moraines
7	HODENPYL-KARLIN: Nearly level and undulating, well drained and somewhat excessively drained loamy and sandy soils on outwash plains

*The texture given in the descriptive headings refers to the texture of the surface layer of the major soils in each association.

Compiled 1983

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FOREST SERVICE
MICHIGAN AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
WEXFORD COUNTY
MICHIGAN

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and letters. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope are for nearly level soils or miscellaneous area.

SYMBOL	NAME
10A	Au Gres-Finch sands, 0 to 4 percent slopes
11A	Croswell sand, 0 to 4 percent slopes
12B	Emmet-Montcalm complex, 0 to 6 percent slopes
12C	Emmet-Montcalm complex, 6 to 12 percent slopes
12D	Emmet-Montcalm complex, 12 to 18 percent slopes
12E	Emmet-Montcalm complex, 18 to 40 percent slopes
13B	Grayling sand, 0 to 6 percent slopes
14A	Allendale loamy sand, 0 to 4 percent slopes
15B	Kalkaska sand, 0 to 6 percent slopes
15C	Kalkaska sand, 6 to 12 percent slopes
15E	Kalkaska sand, 12 to 40 percent slopes
16B	Hodenpyl-Karlin complex, 0 to 4 percent slopes
17A	Kawkawlin loam, 0 to 4 percent slopes
18	Loxley peat
19	Lupton muck
20B	Montcalm-Graycalm complex, 0 to 6 percent slopes
20C	Montcalm-Graycalm complex, 6 to 12 percent slopes
20E	Montcalm-Graycalm complex, 12 to 30 percent slopes
21B	Nester sandy loam, 1 to 6 percent slopes
21C	Nester sandy loam, 6 to 12 percent slopes
21E	Nester loam, 12 to 40 percent slopes
22	Tawas-Roscommon association
23B	Rubicon sand, 0 to 12 percent slopes
23E	Rubicon sand, 12 to 40 percent slopes
24D	Rubicon sand, 12 to 40 percent slopes, severely eroded
25	Pits
26B	Manistee-Montcalm loamy sands, 0 to 6 percent slopes
26C	Manistee-Montcalm loamy sands, 6 to 12 percent slopes
28C	Dighton loam, 6 to 12 percent slopes
29B	Graycalm-Grayling sands, 0 to 6 percent slopes
29D	Graycalm-Grayling sands, 6 to 30 percent slopes
30B	Kalkaska-East Lake sands, 0 to 6 percent slopes
30C	Kalkaska-East Lake sands, 6 to 12 percent slopes
30E	Kalkaska-East Lake sands, 12 to 30 percent slopes
34	Winterfield sand
35B	Mancelona-East Lake complex, 0 to 6 percent slopes
36B	Kalkaska sand, banded substratum, 0 to 6 percent slopes
36C	Kalkaska sand, banded substratum, 6 to 12 percent slopes
36E	Kalkaska sand, banded substratum, 12 to 40 percent slopes
37	Fluvaquents and Histosols

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water — w
- Intermittent — int — i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 10A 24D

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

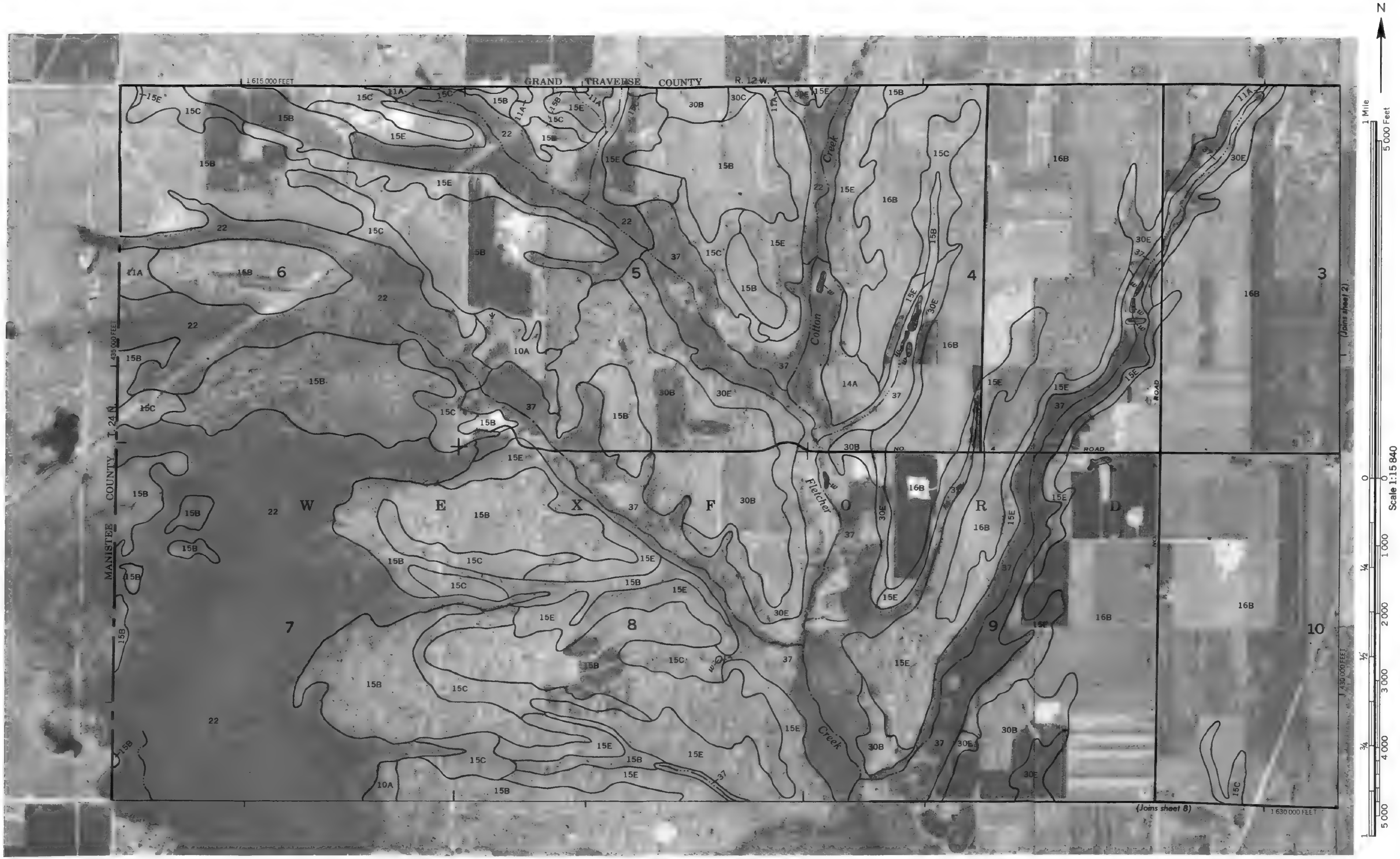
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Cut and Fill Area
- Loamy Spot
- Sanitary Land Fill

1



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 1

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

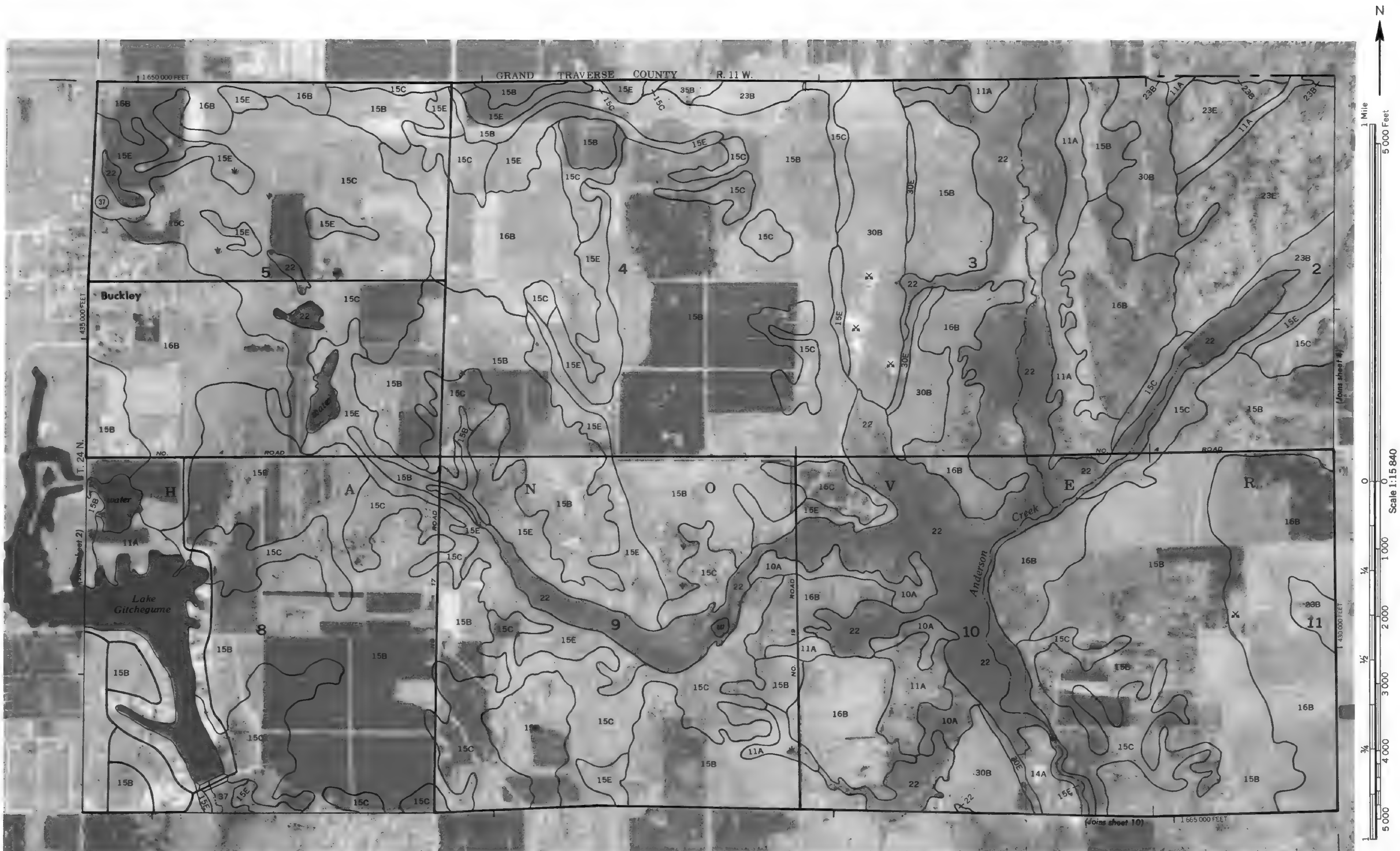
2

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 2

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 3

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



4

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 4

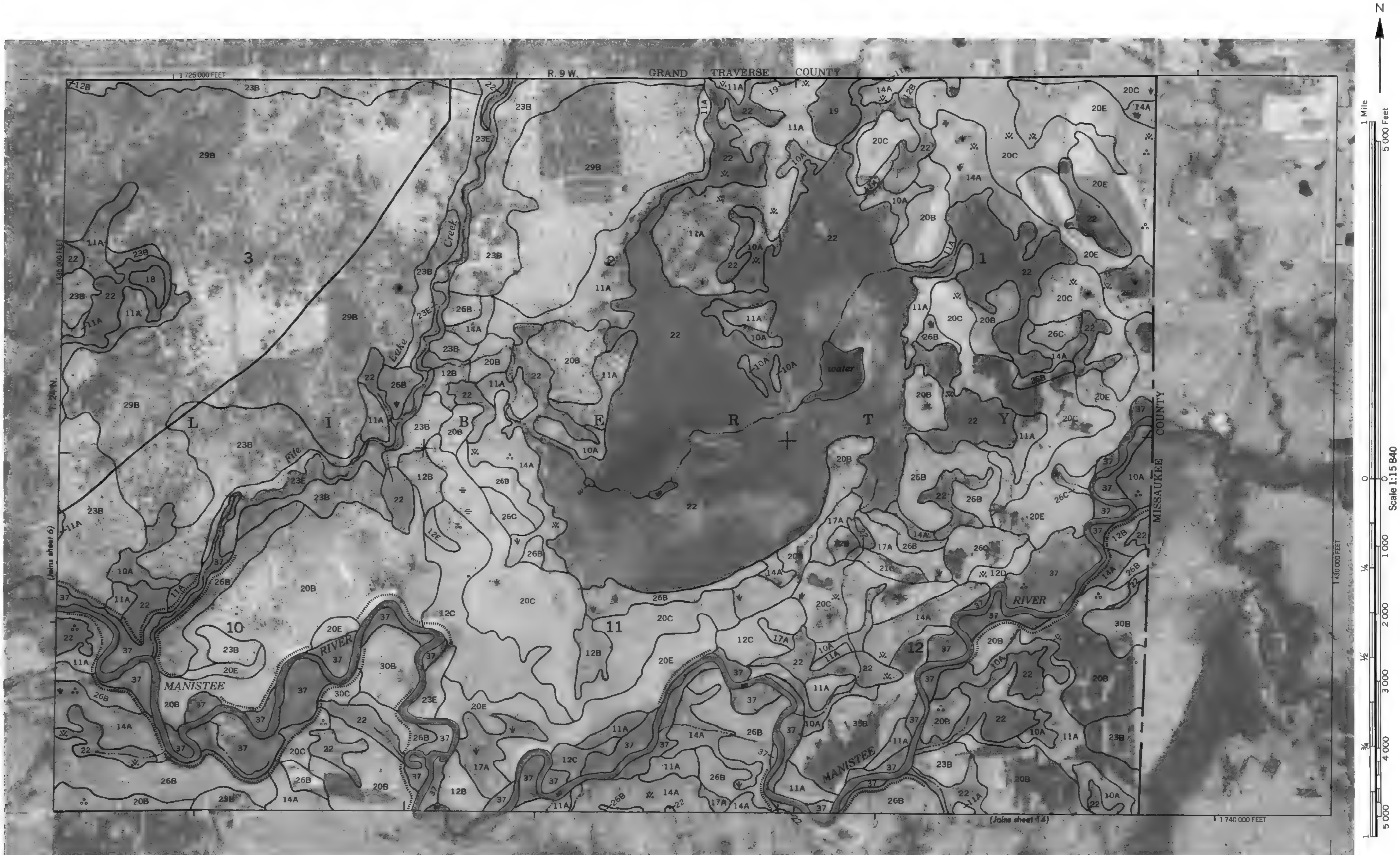
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 5

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

6

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 6



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 7

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 8

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 8

9

N

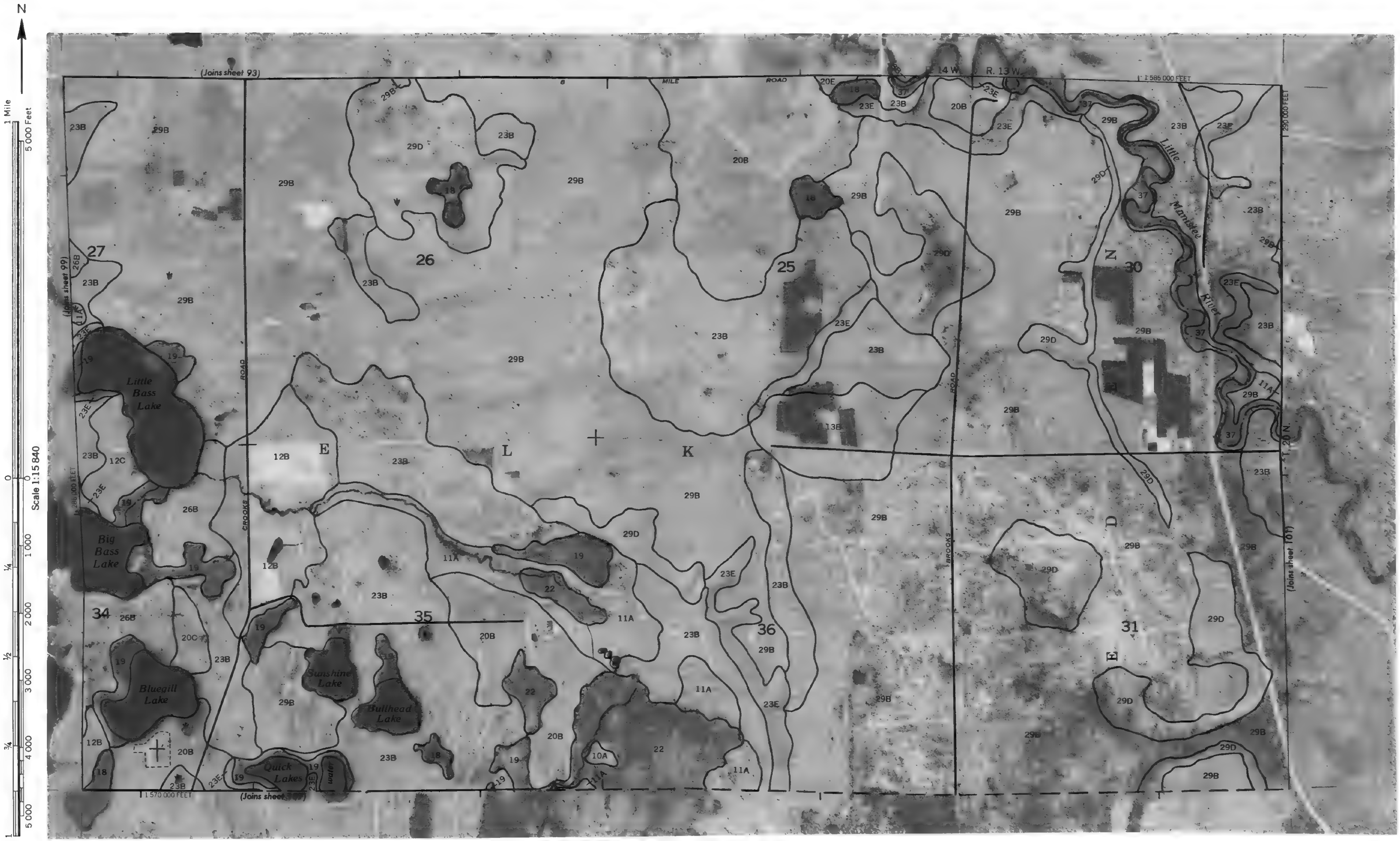
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 9

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

10

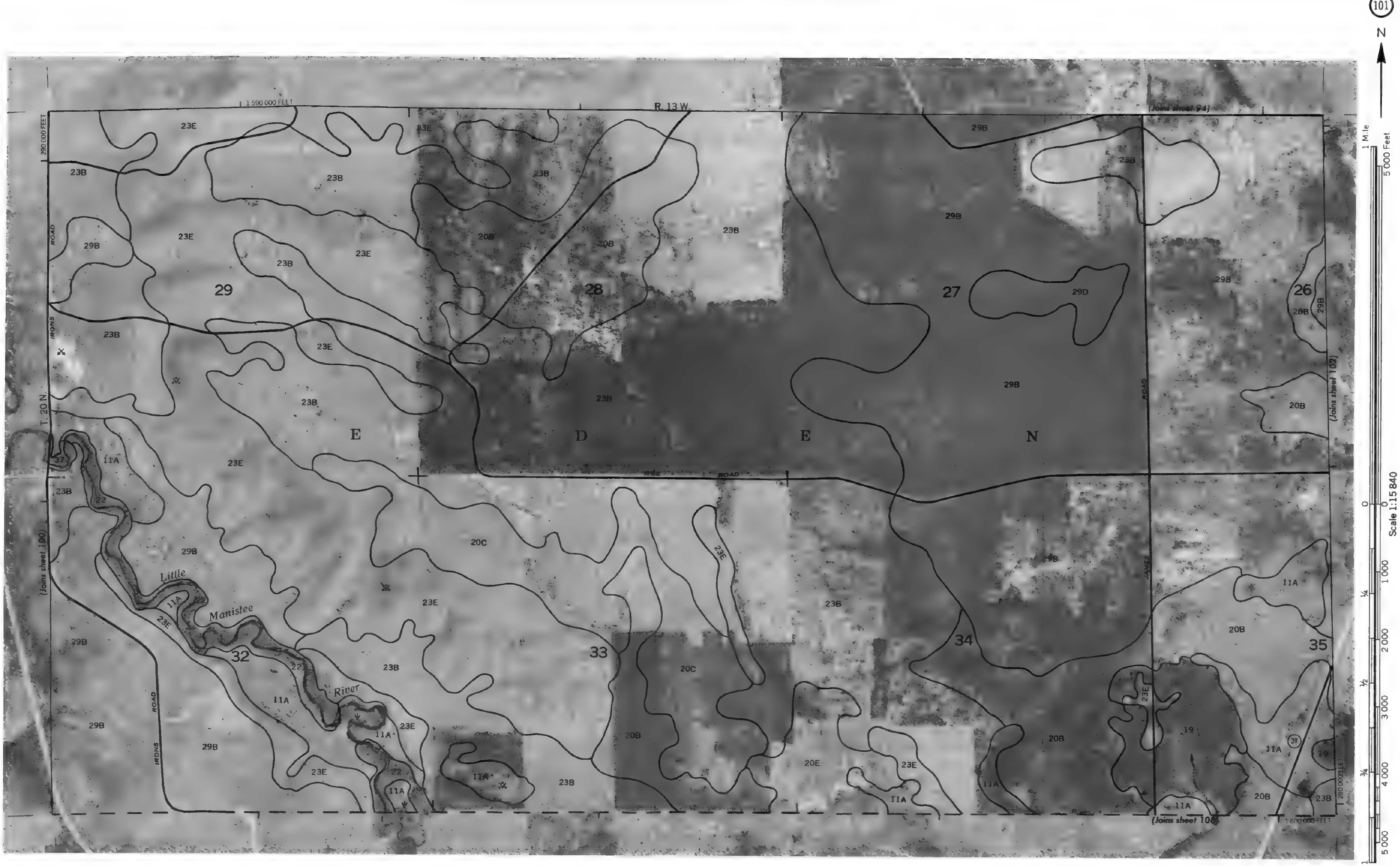
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 10



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

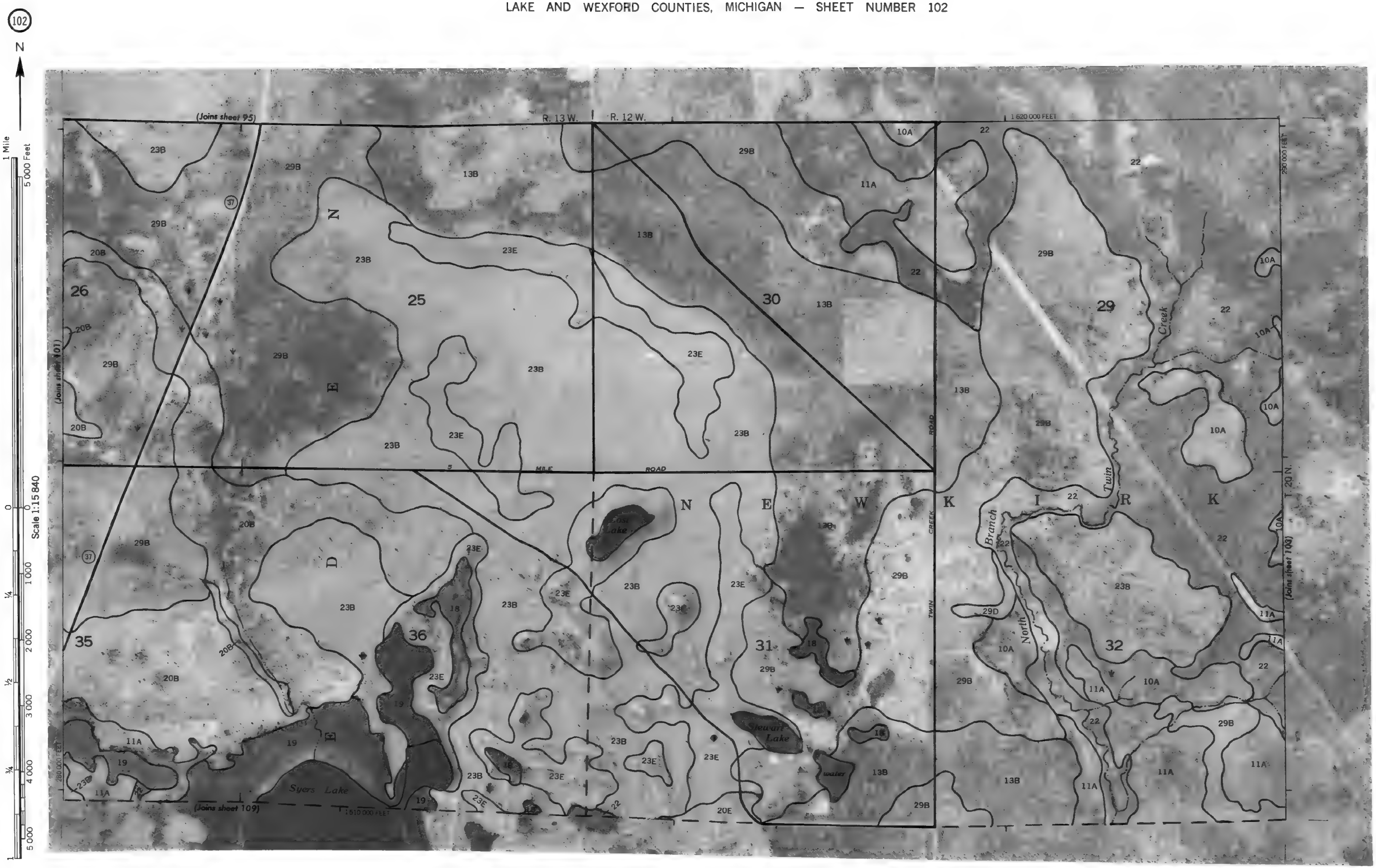
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 100



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 101

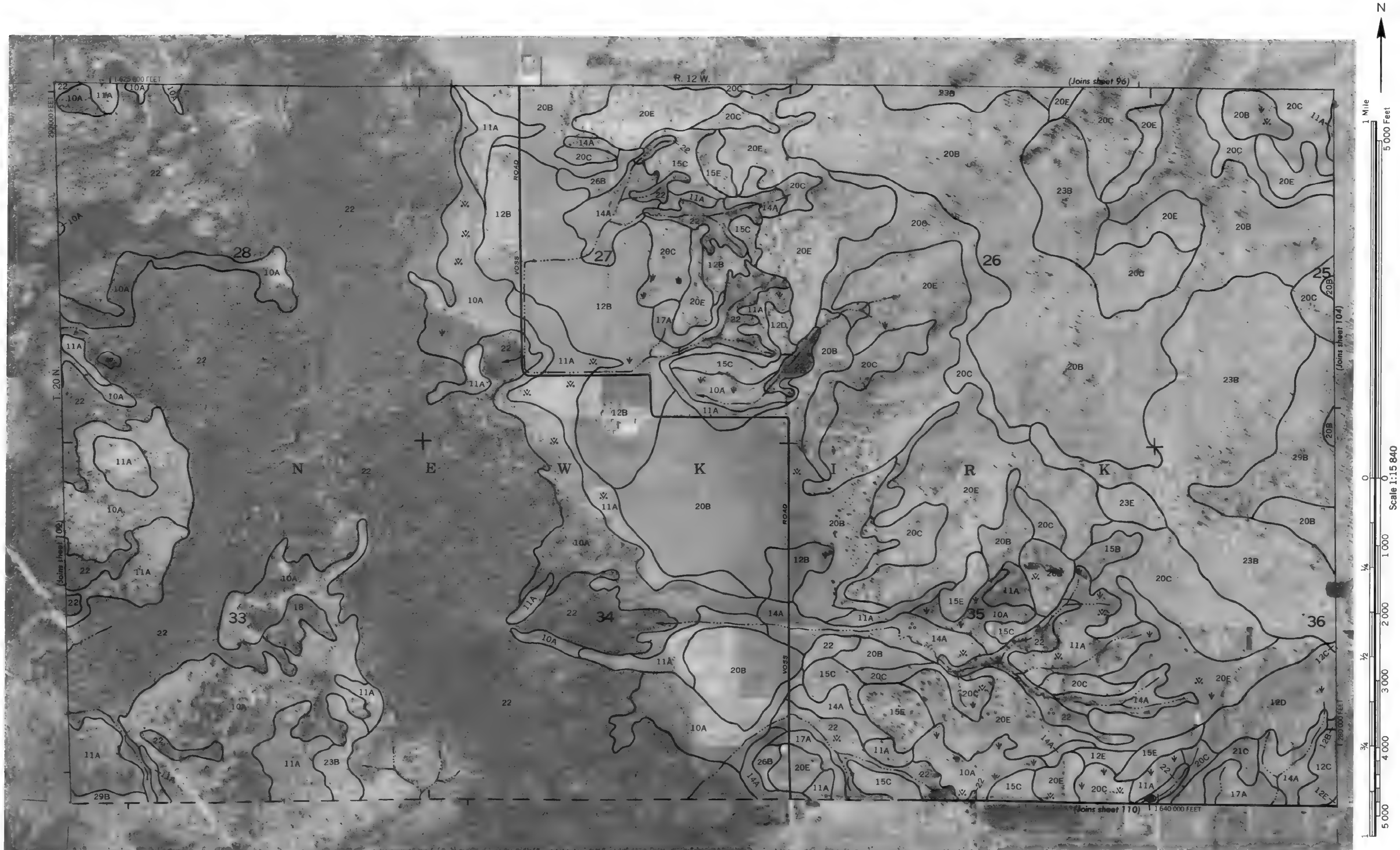
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 102



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

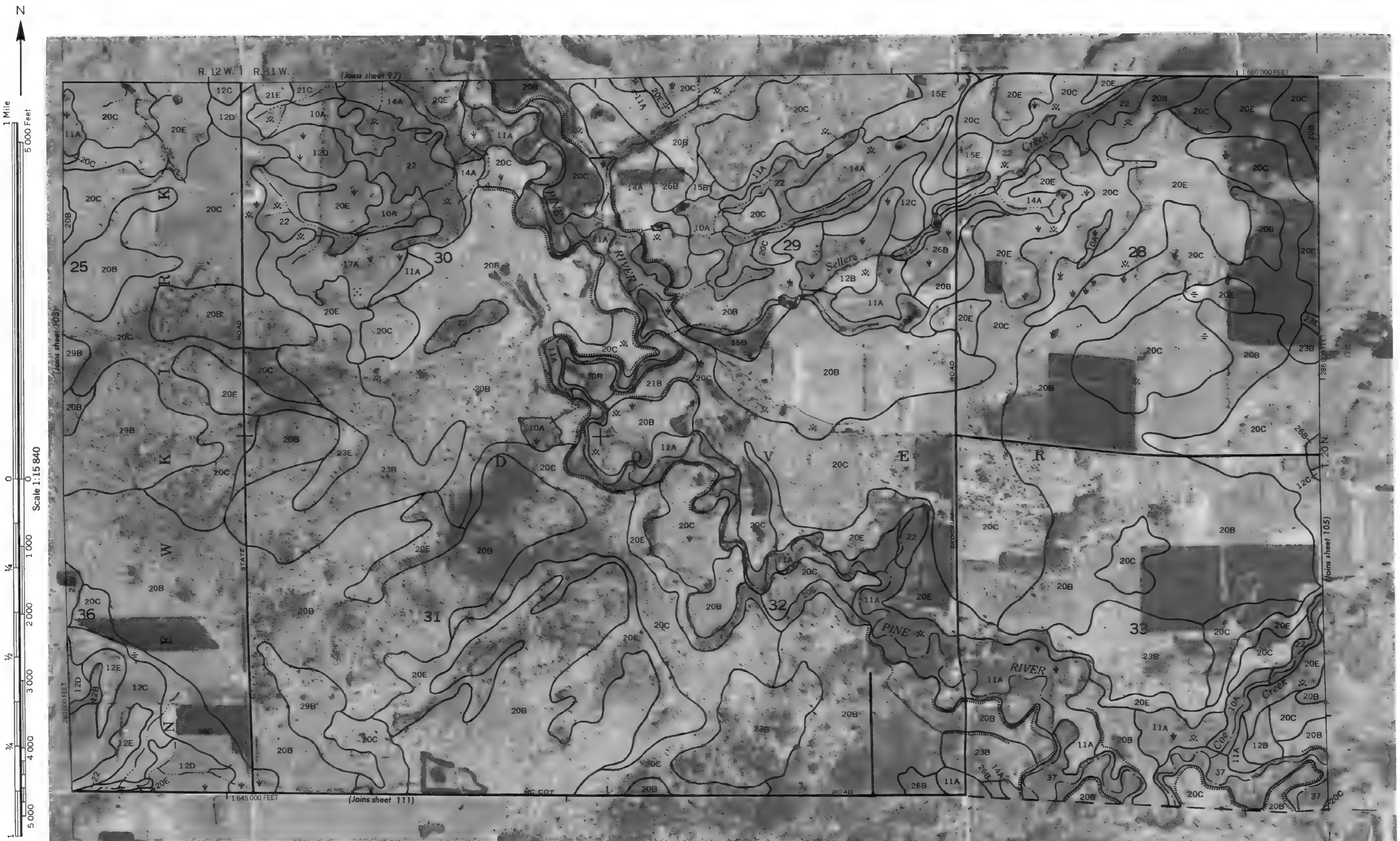
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 102



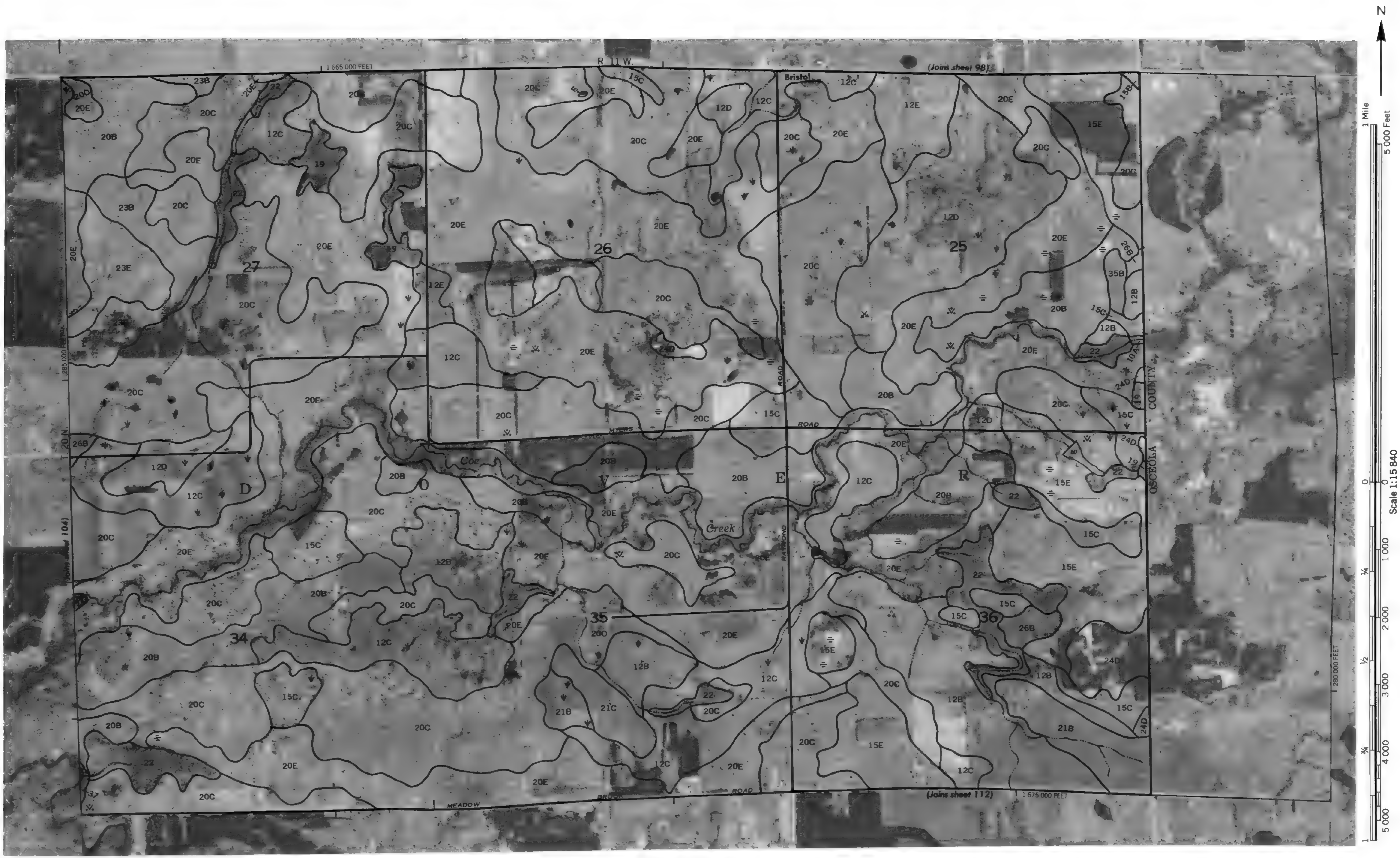
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 103

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 104



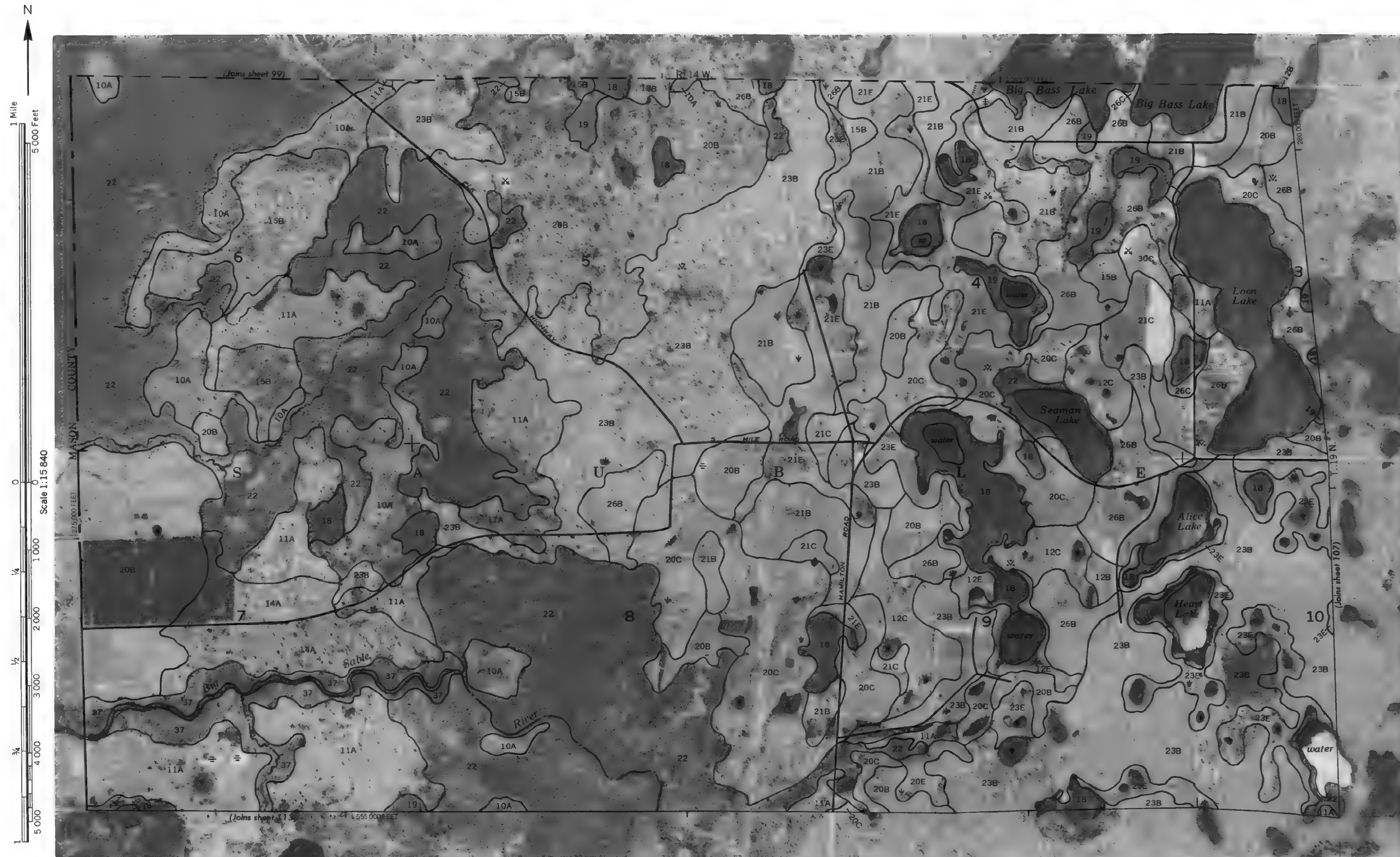
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



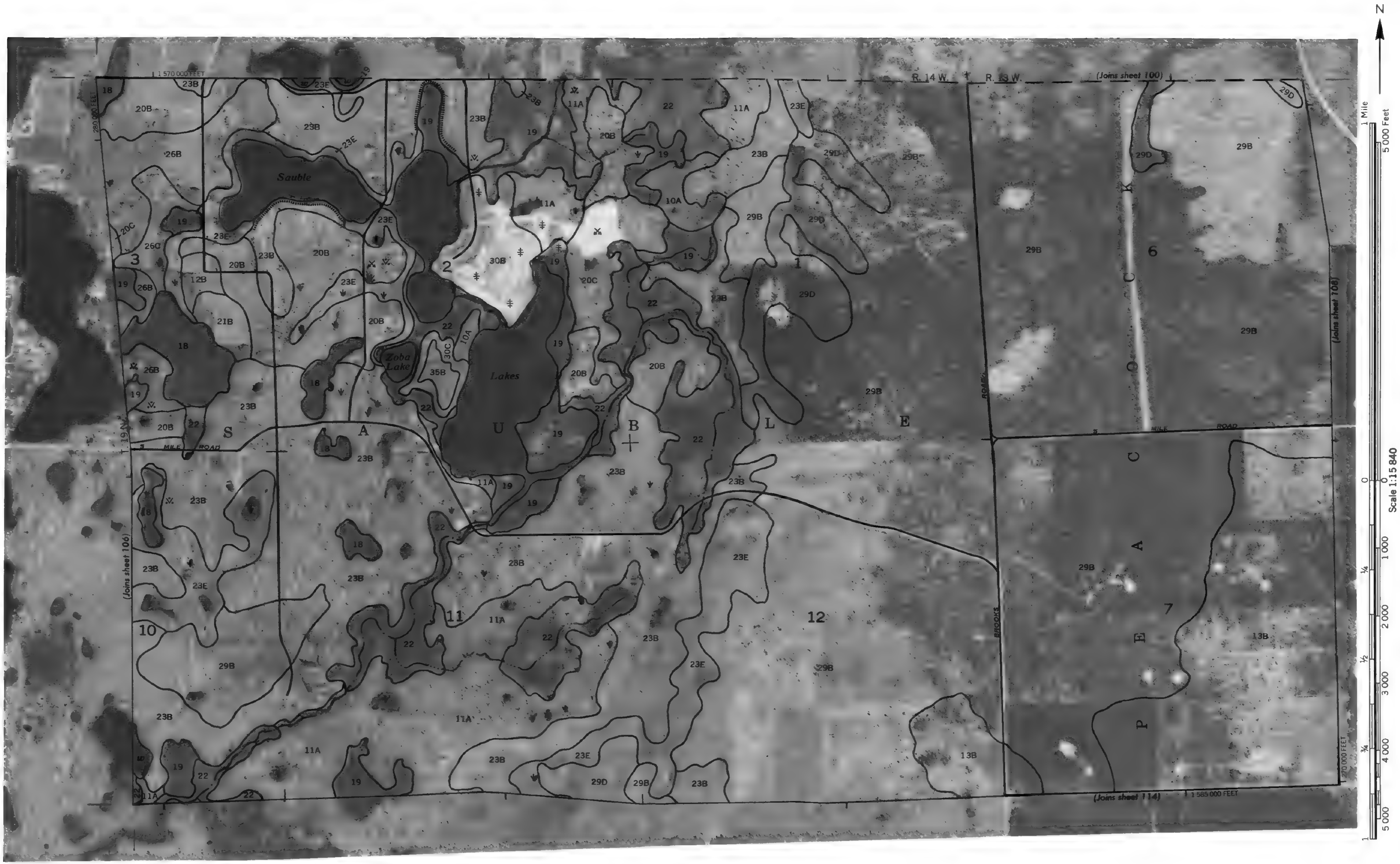
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 105

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 106

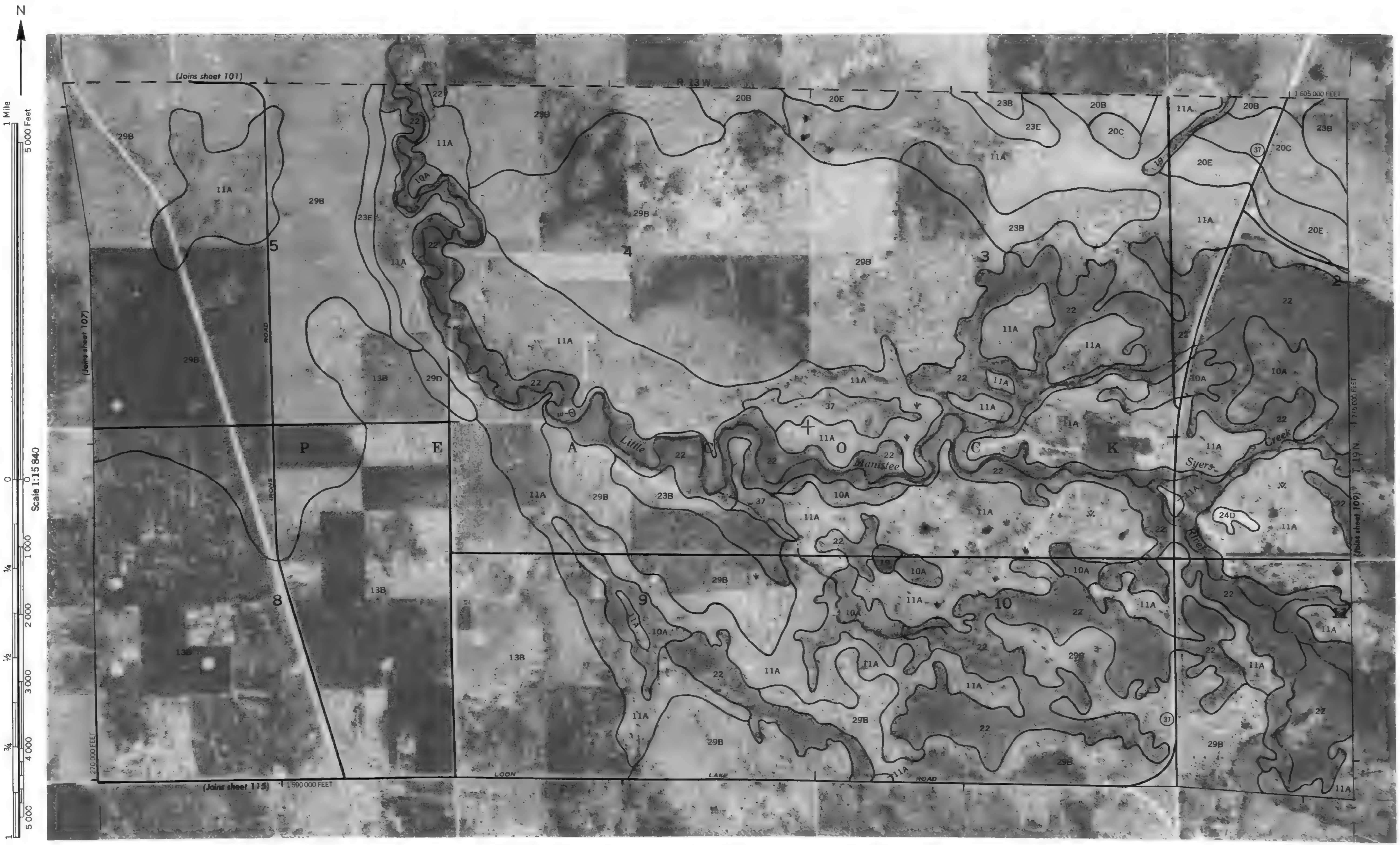


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 107

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

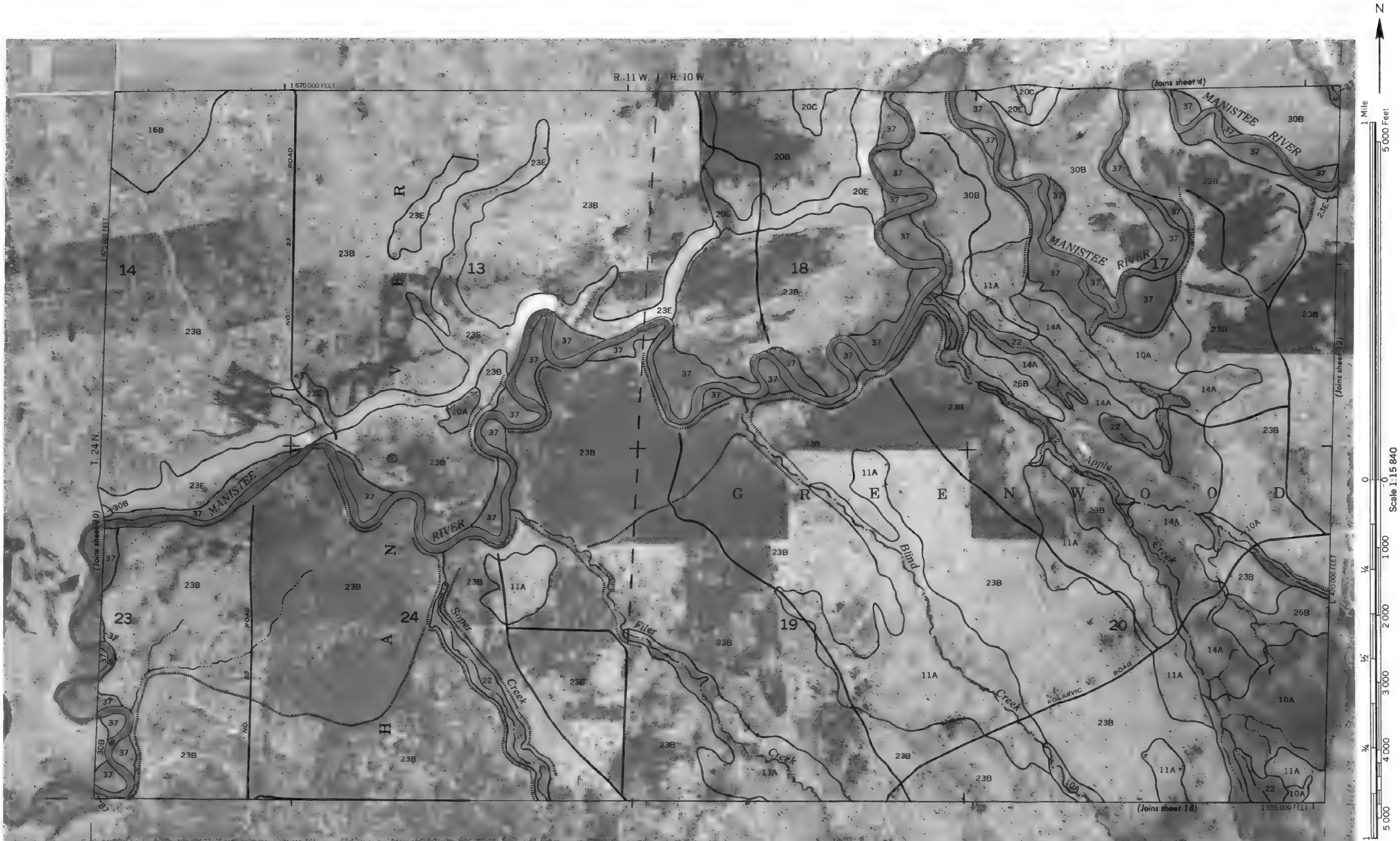
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 108

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 109

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 11

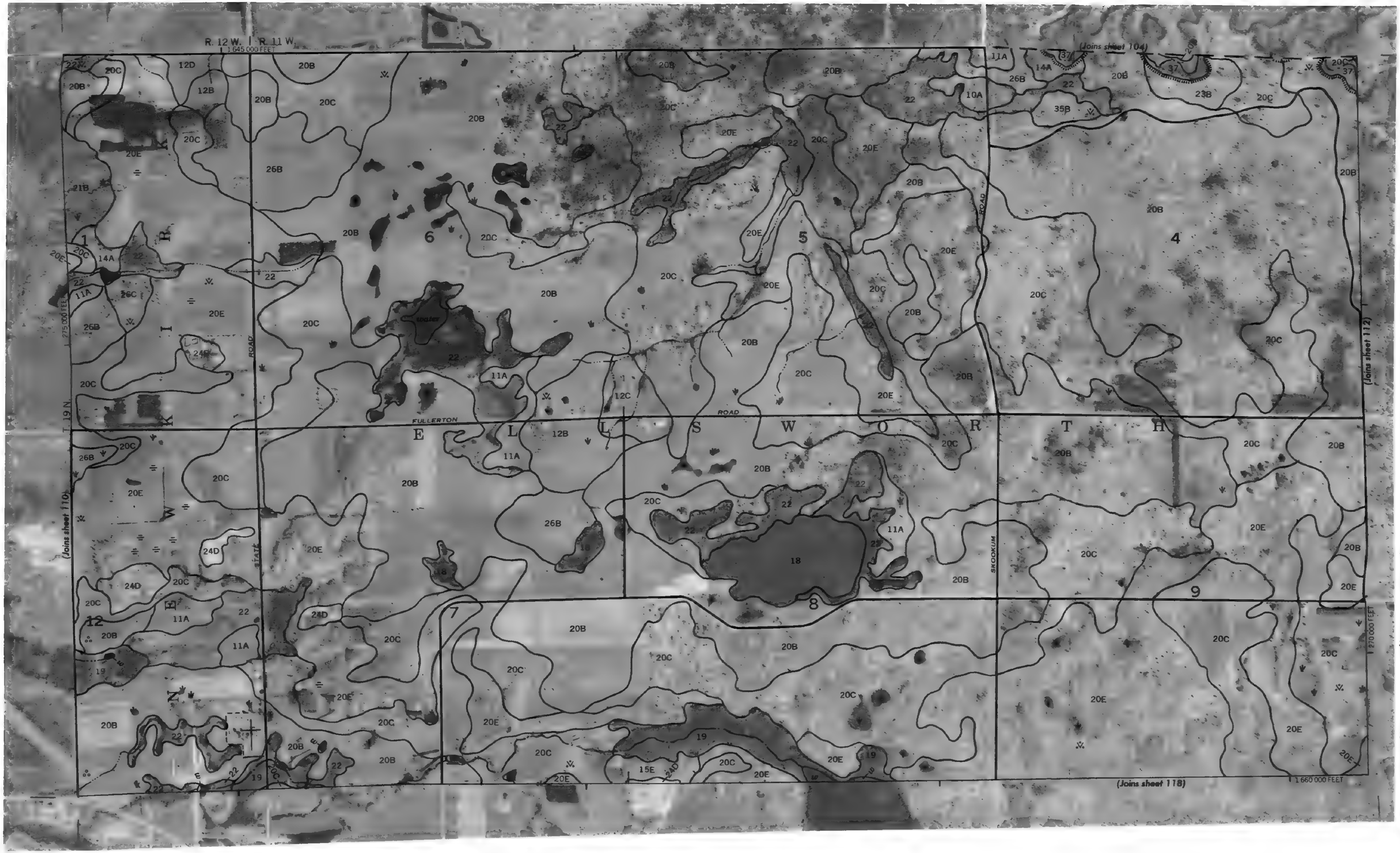
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 110

111



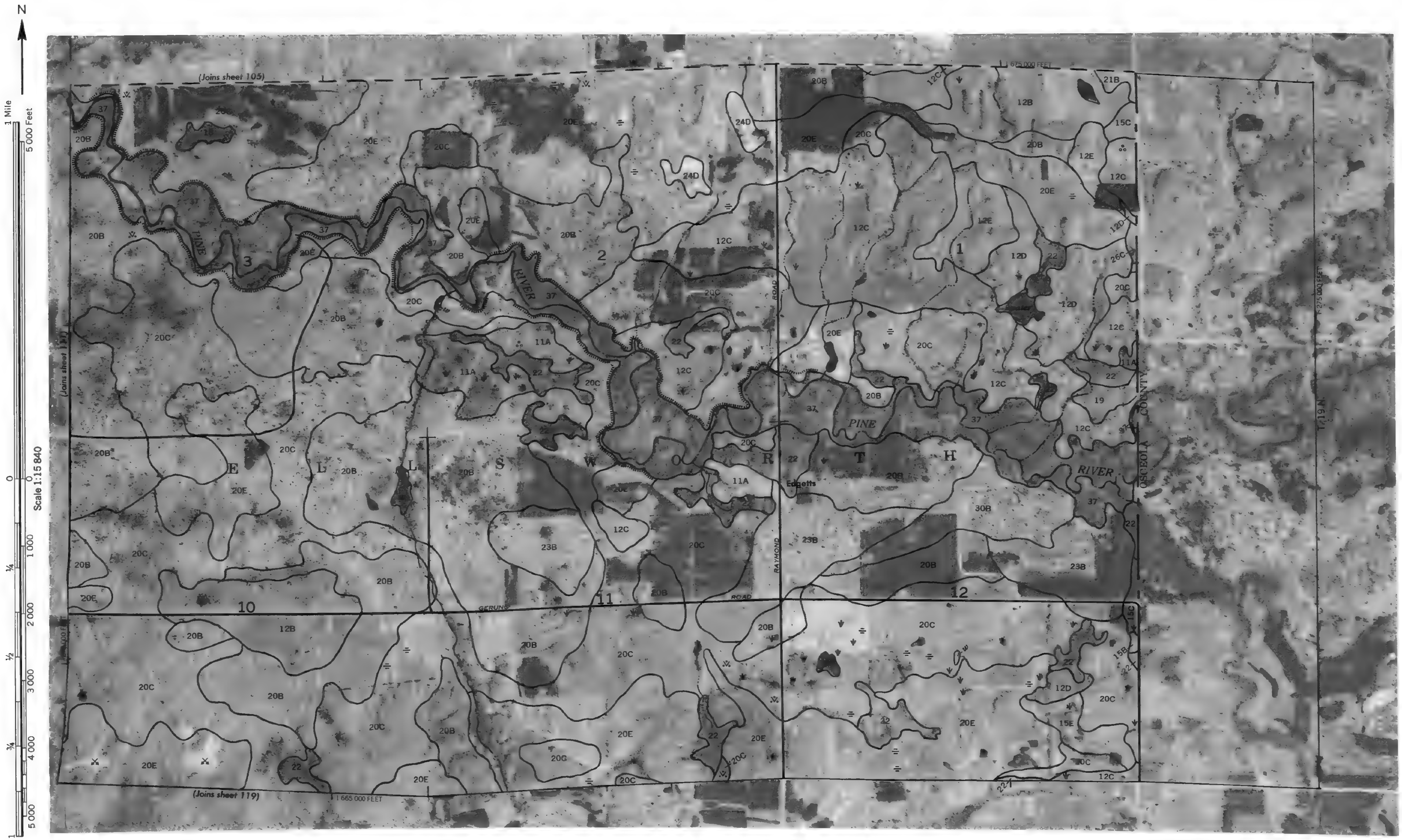
N

1 Mile
5 000 Feet
Scale 1:15 840
0 1/4 1/2 3/4 1
0 1000 2000 3000 4000 5000

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 111

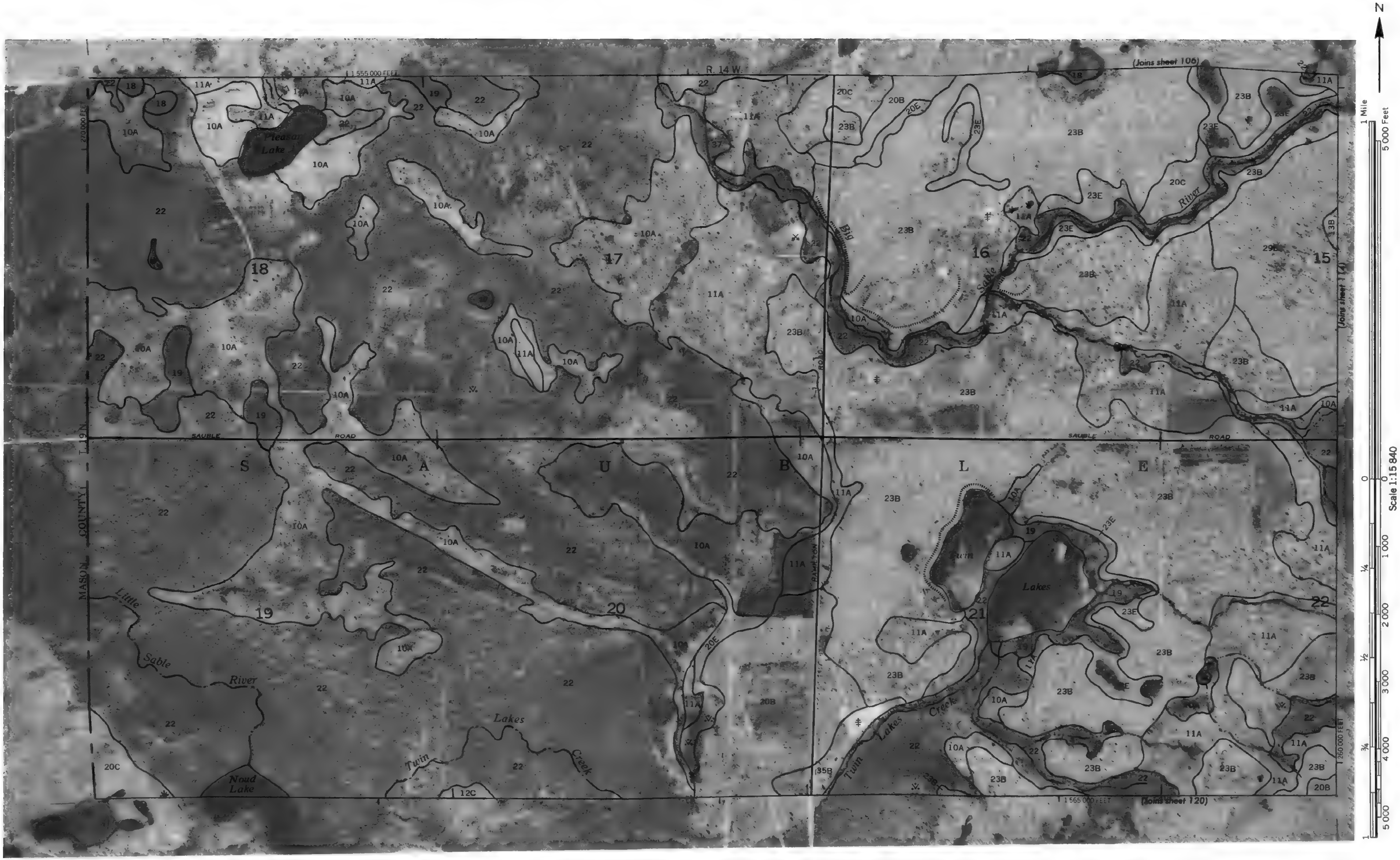
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approx imately positioned.

112



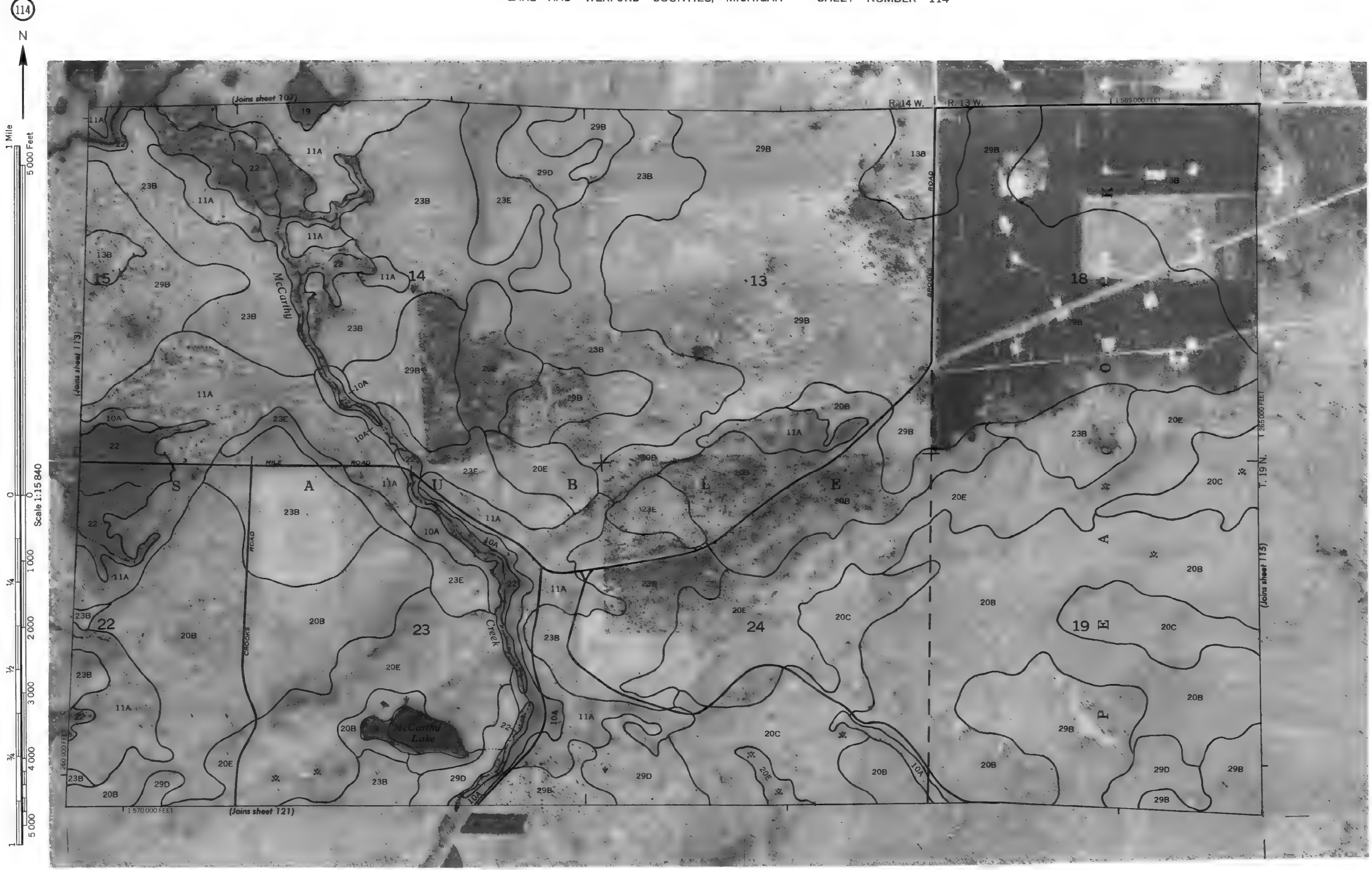
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 112



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 113

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

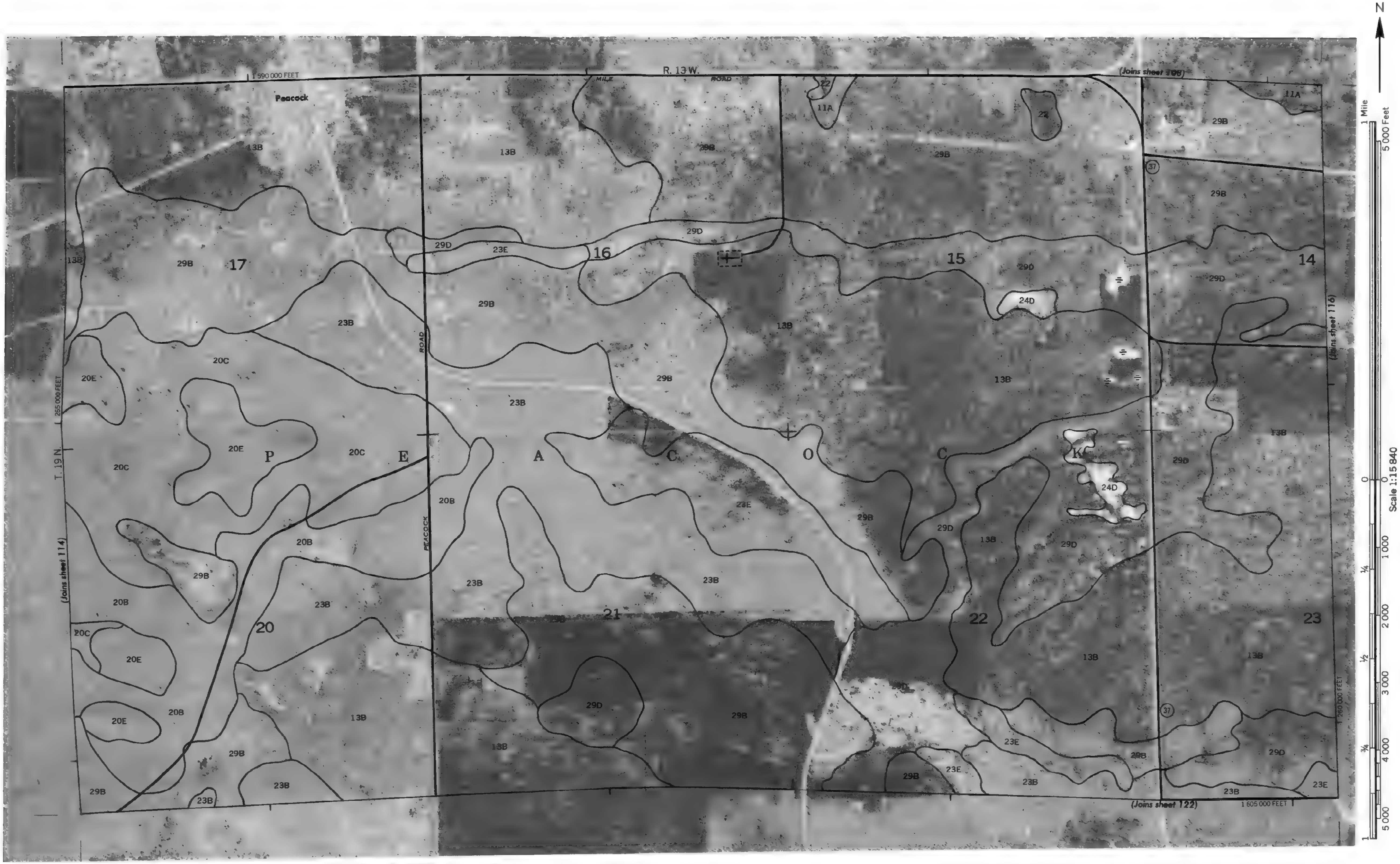


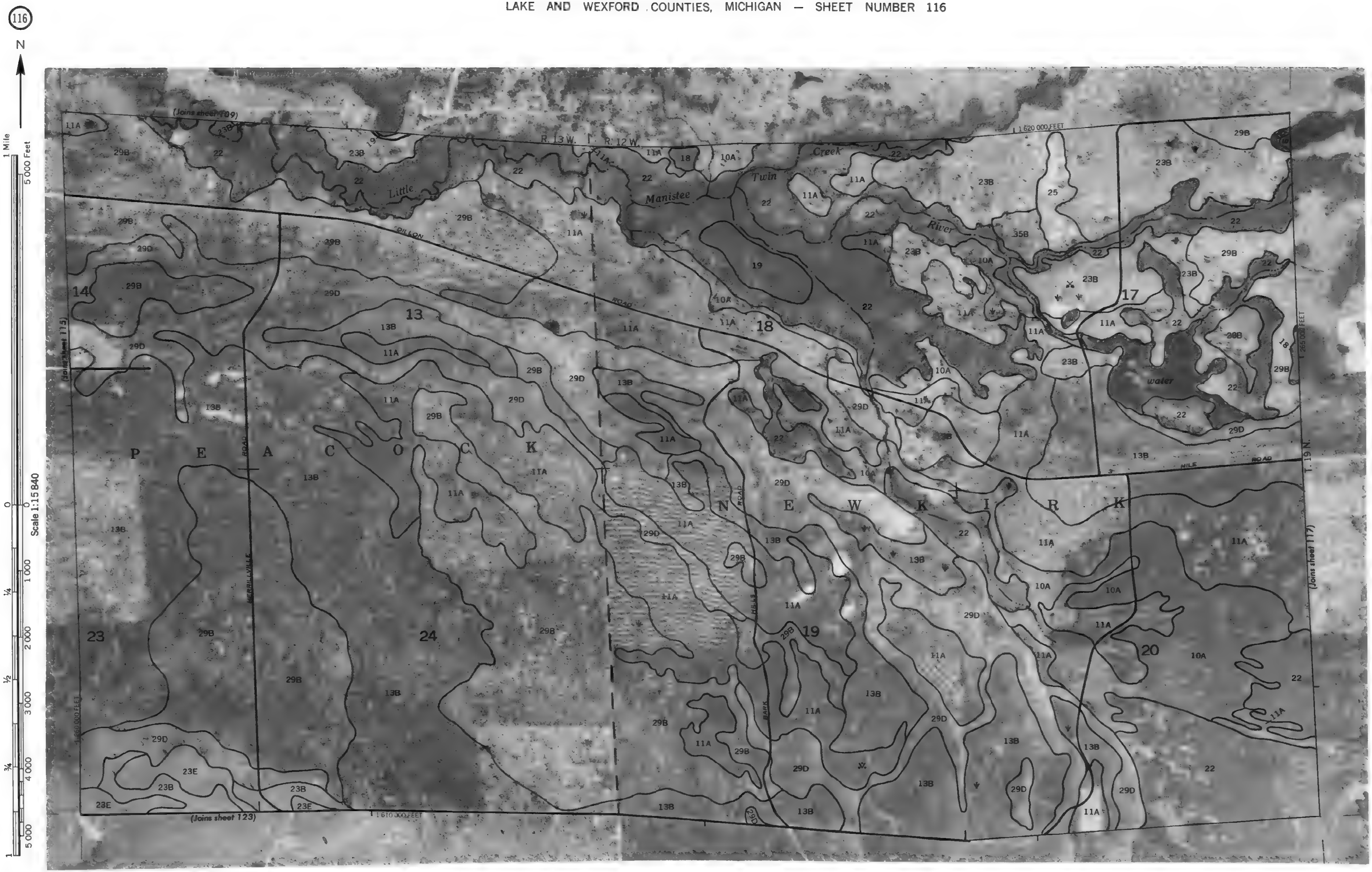
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 114

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 115

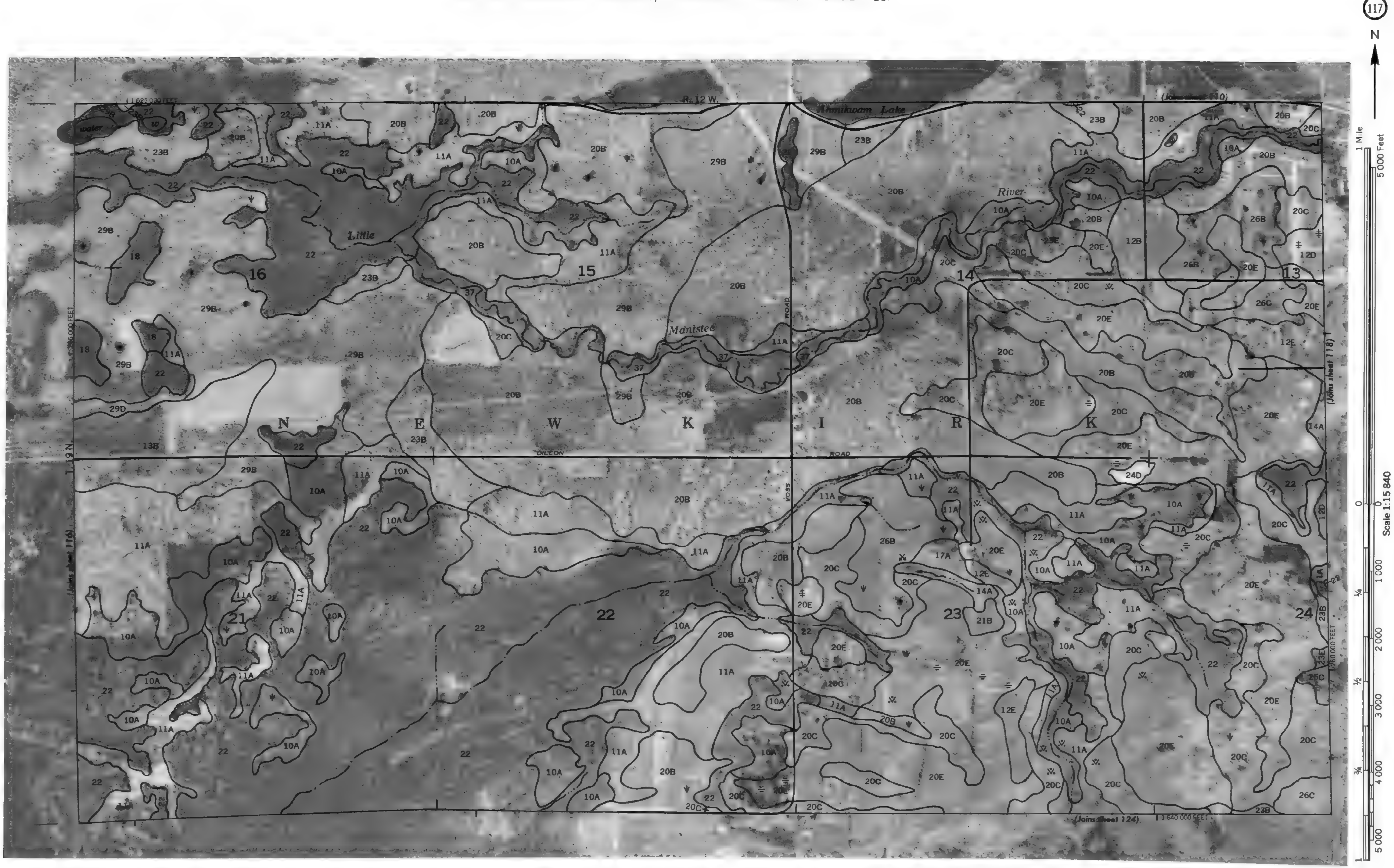
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 116



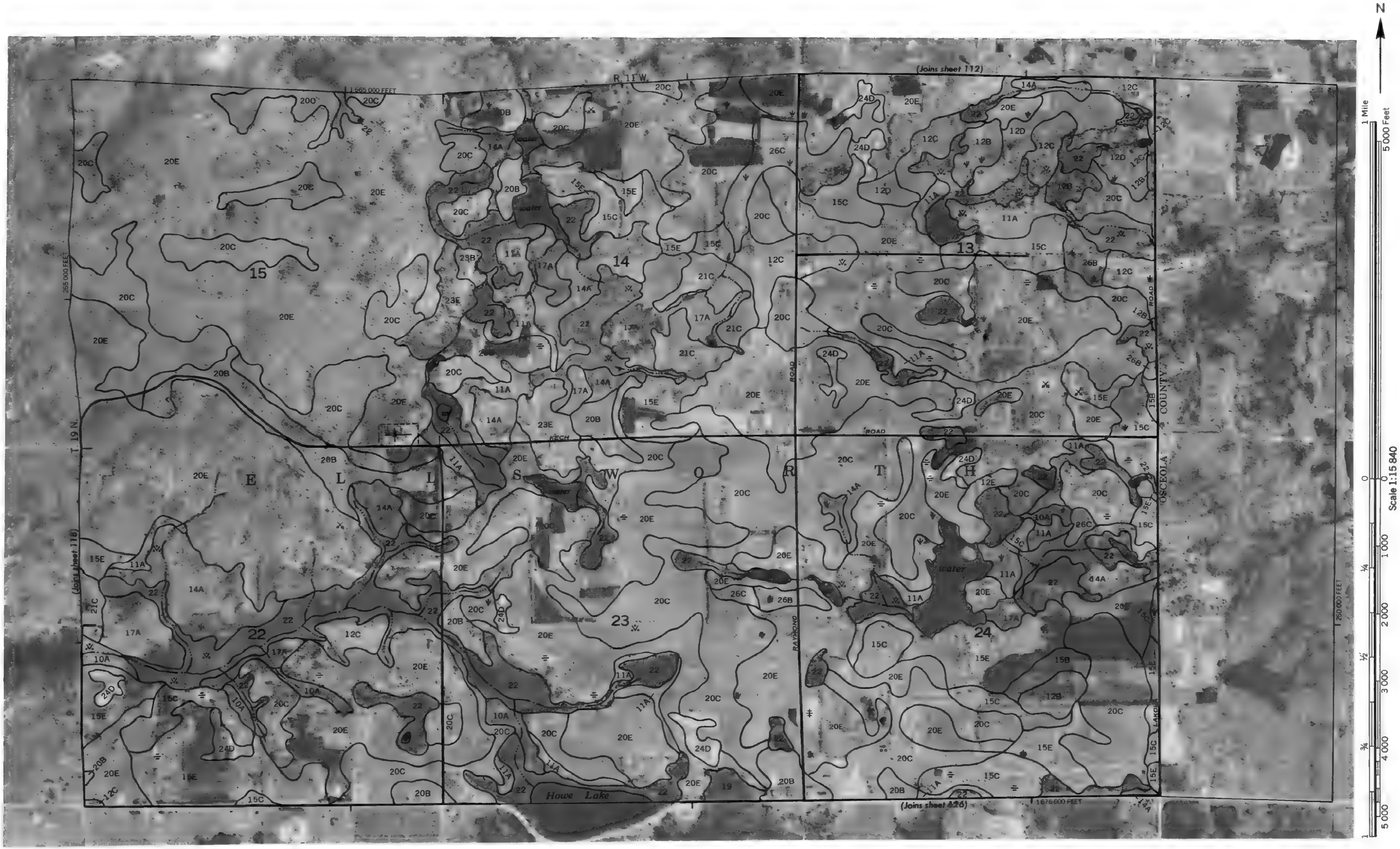
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 117

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 118

119

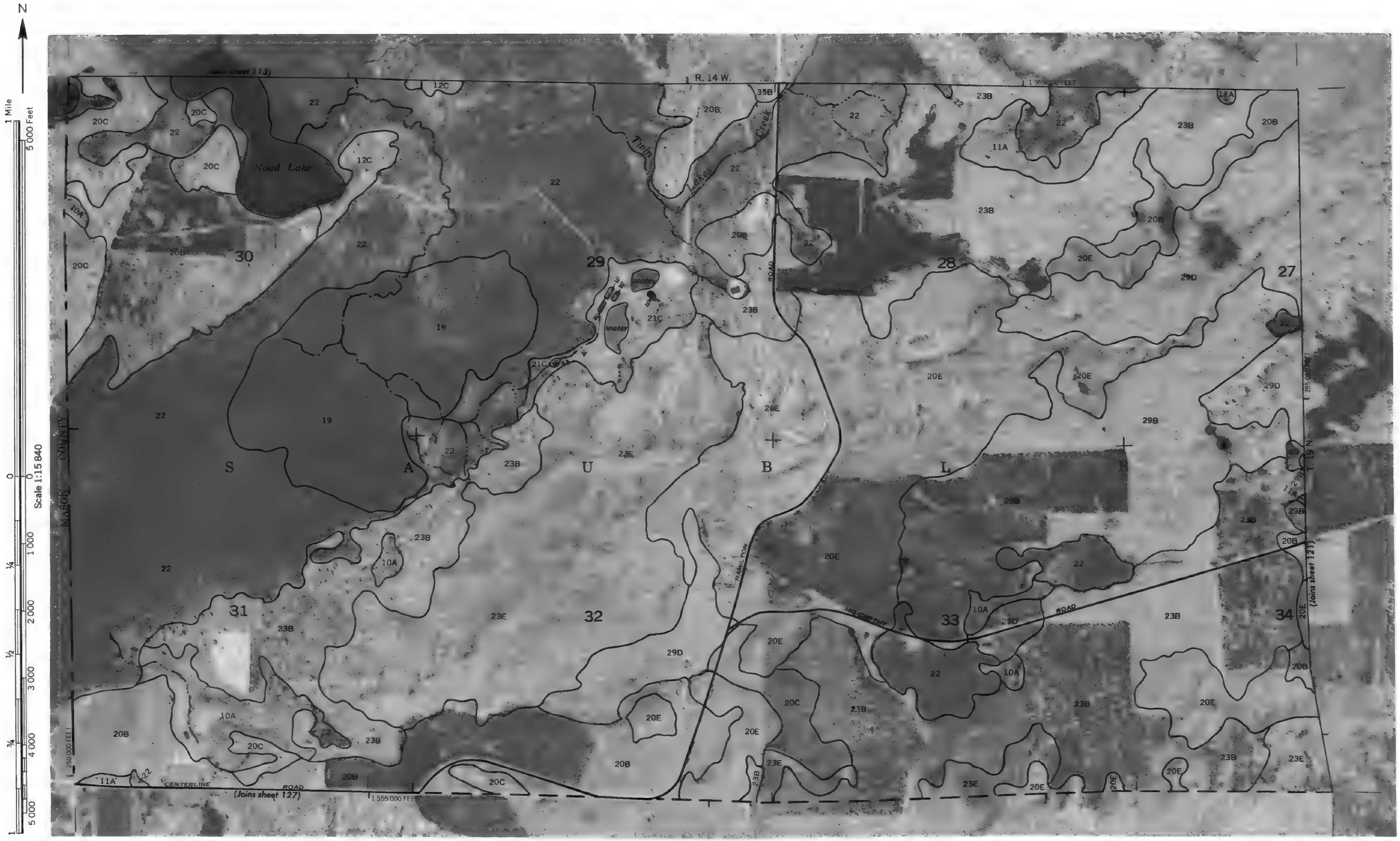


LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 119

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

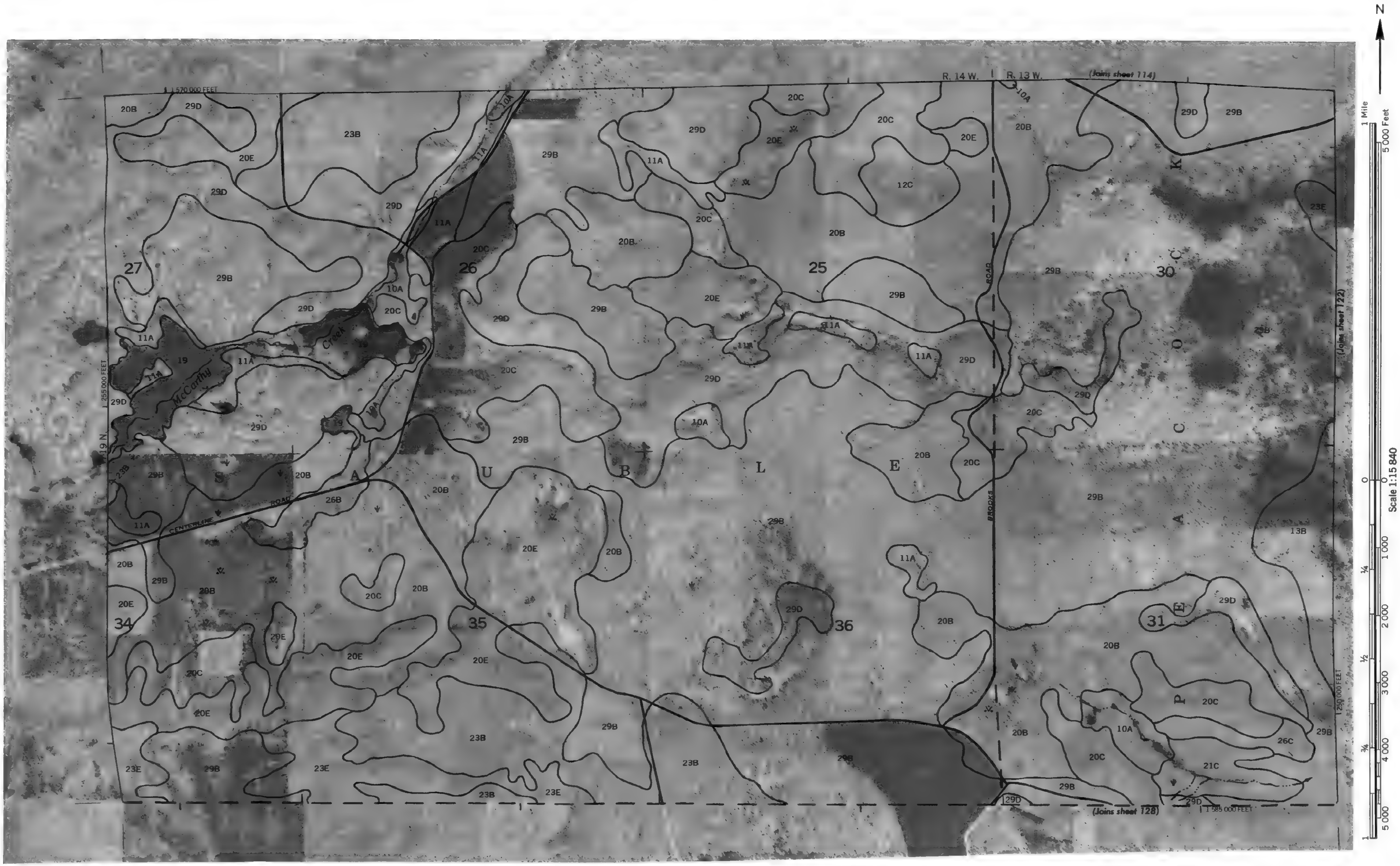
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

120



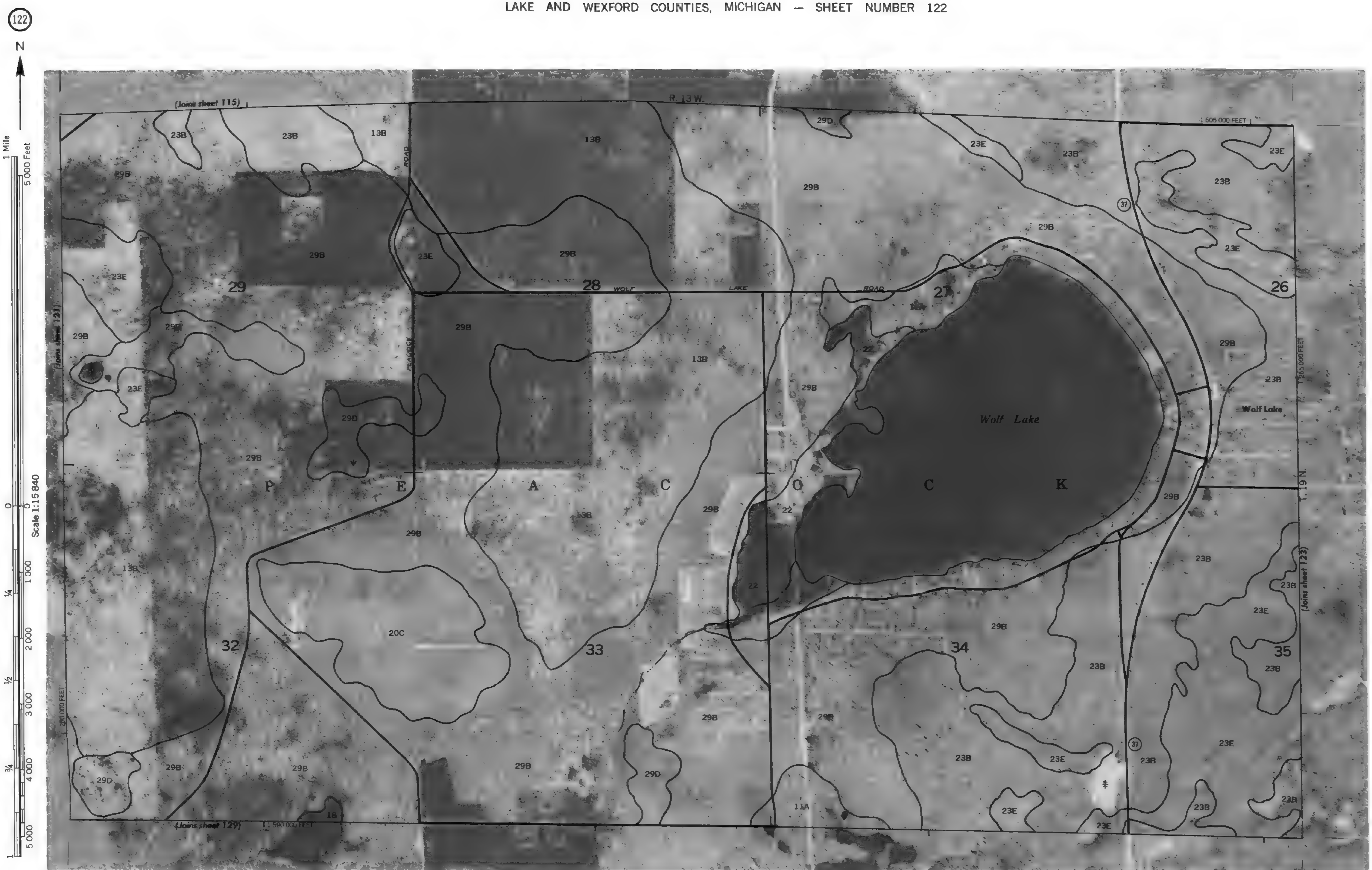
This map is compiled on 1976 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 120



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 121

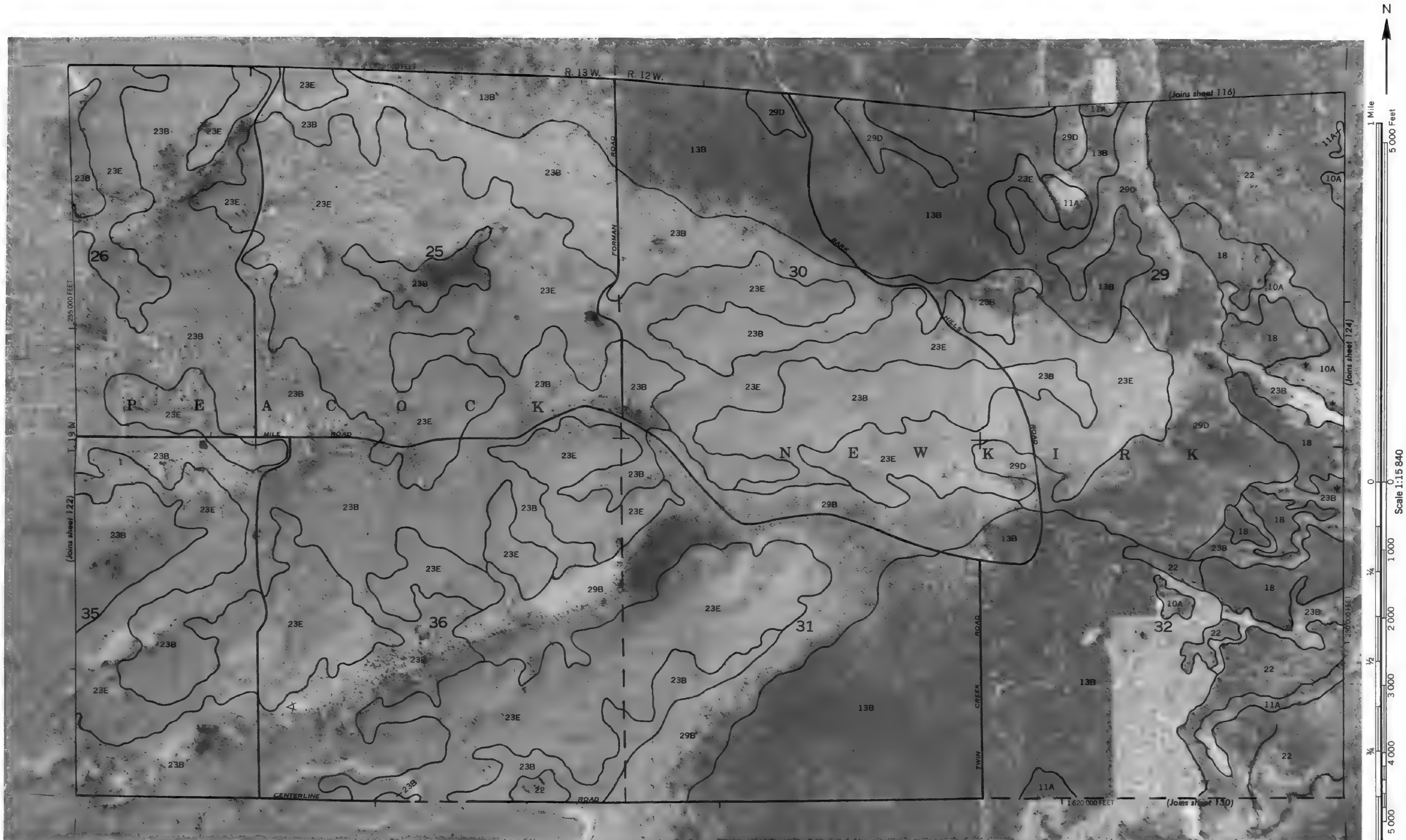
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

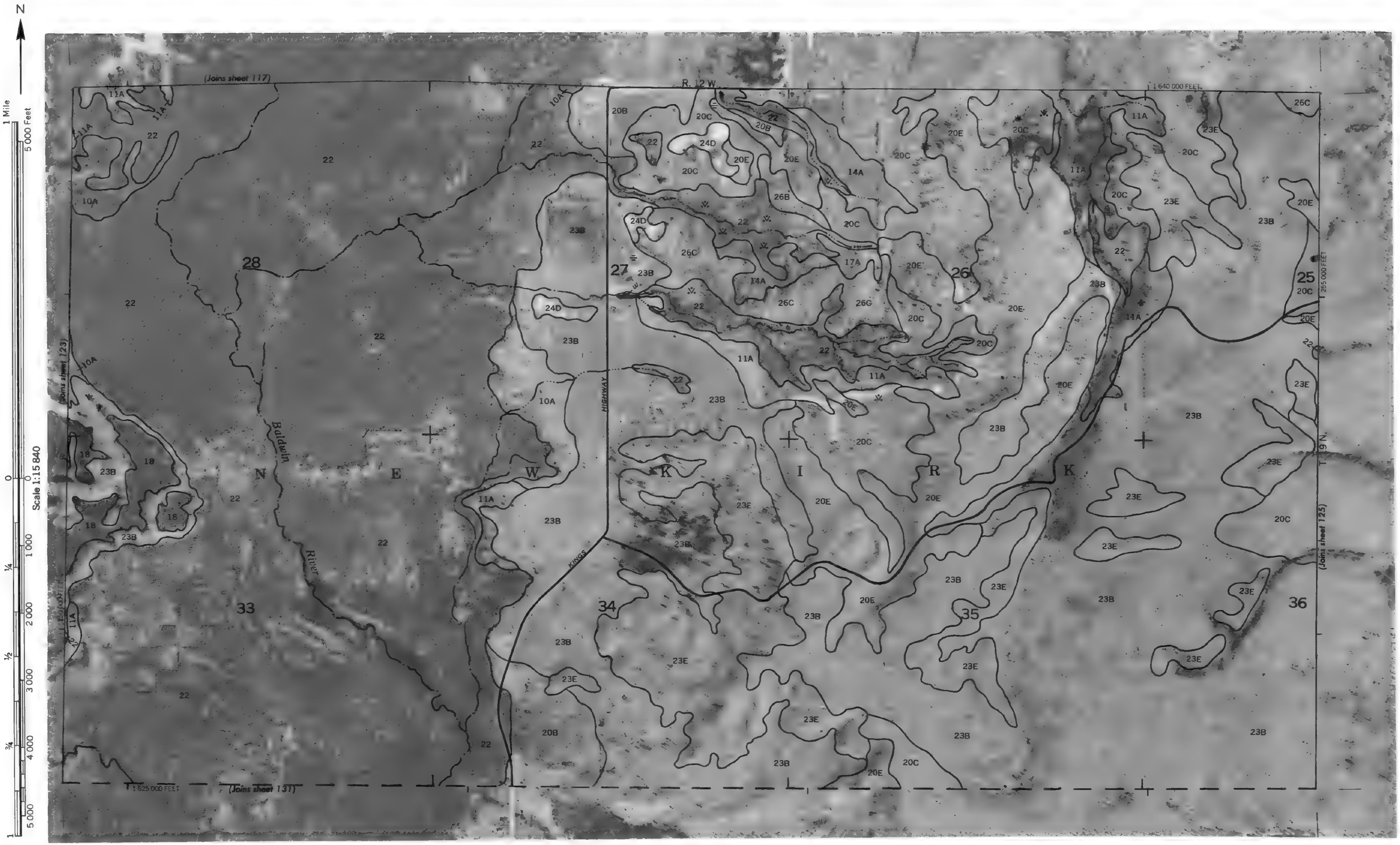
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 122

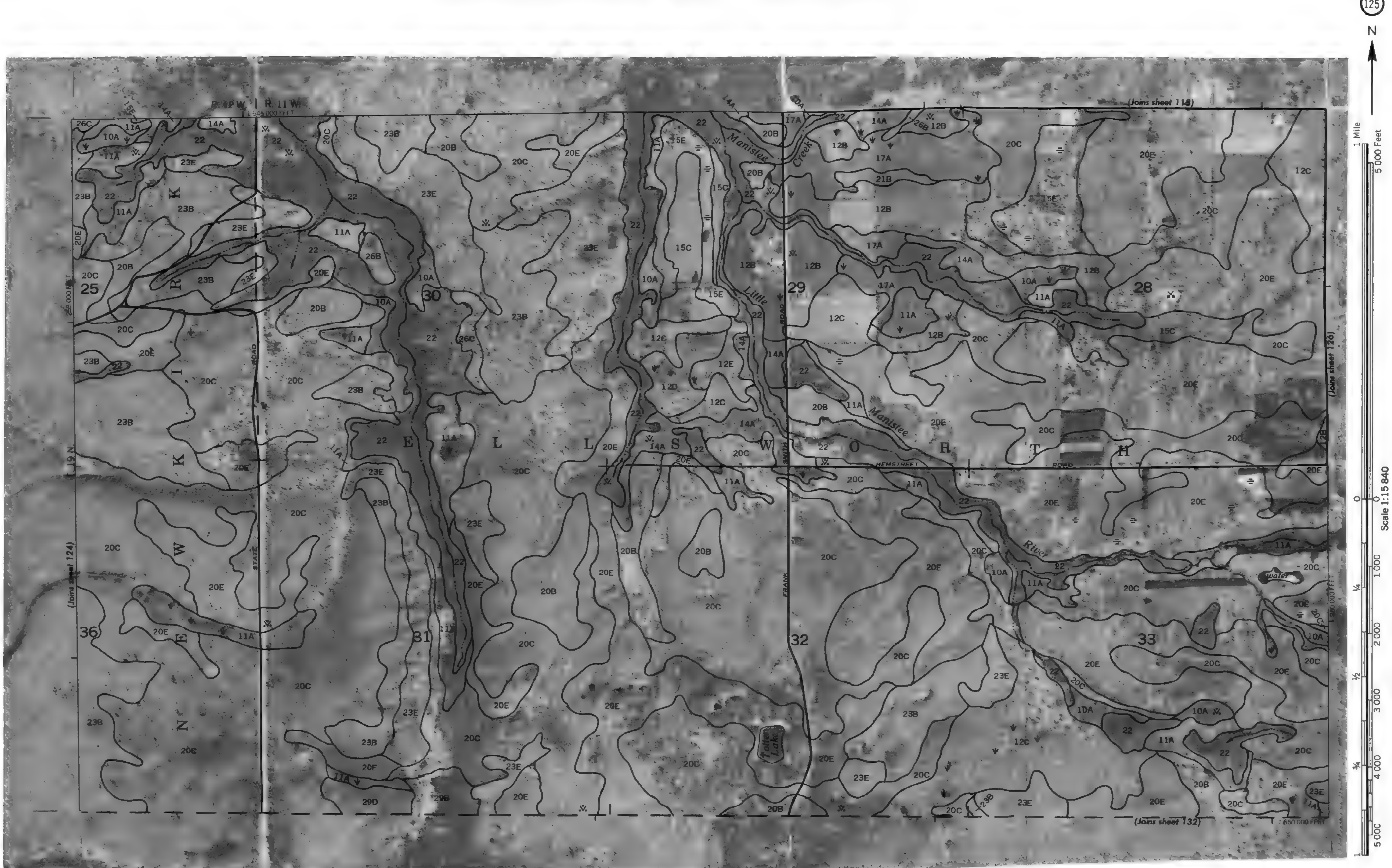
123



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 123

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

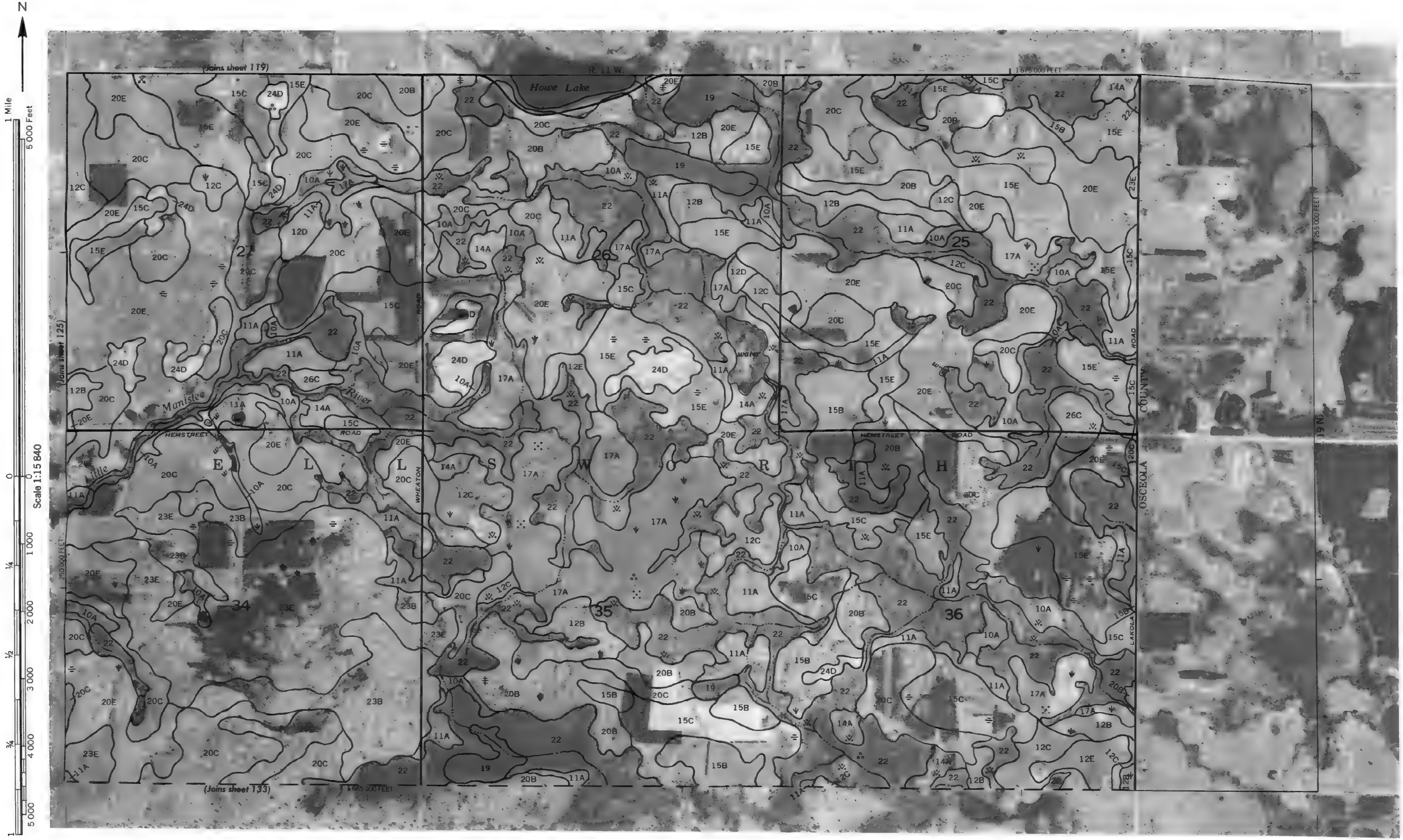

124
N
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000
(Joins sheet 117)
R. 12 W.
1 640 000 FEET
(Joins sheet 123)
(Joins sheet 125)
(Joins sheet 131)
1 625 000 FEET
265 000 FEET
T. 19 N.
Baldwin
River
KINGS
HIGHWAY
N
E
W
K
I
R
K
28
27
26
25
33
34
35
36
10A
11A
14A
17A
18
20B
20C
20E
22
23B
23E
24D
26B
26C



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 125

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

126

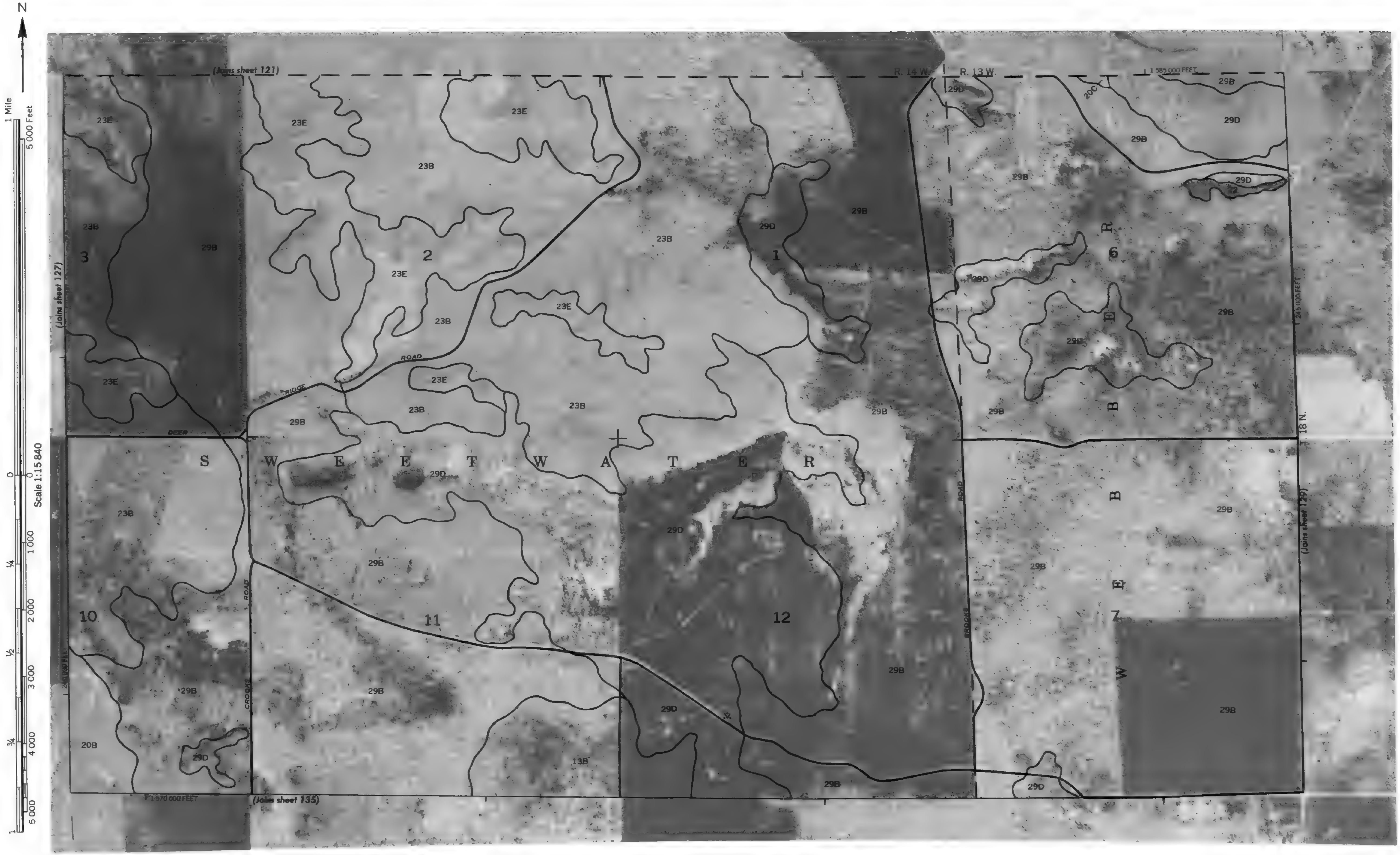


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 126

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 127

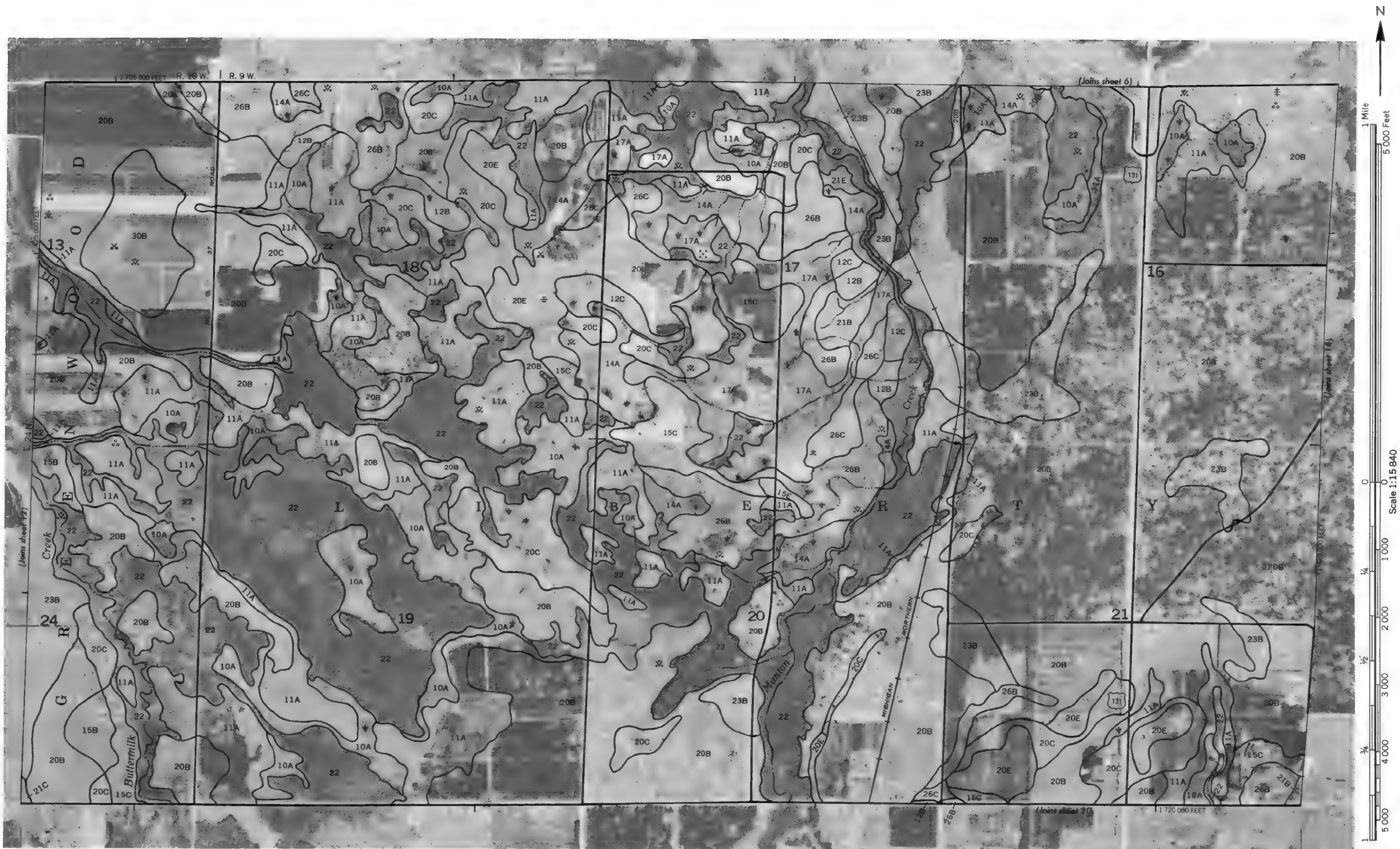
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 129

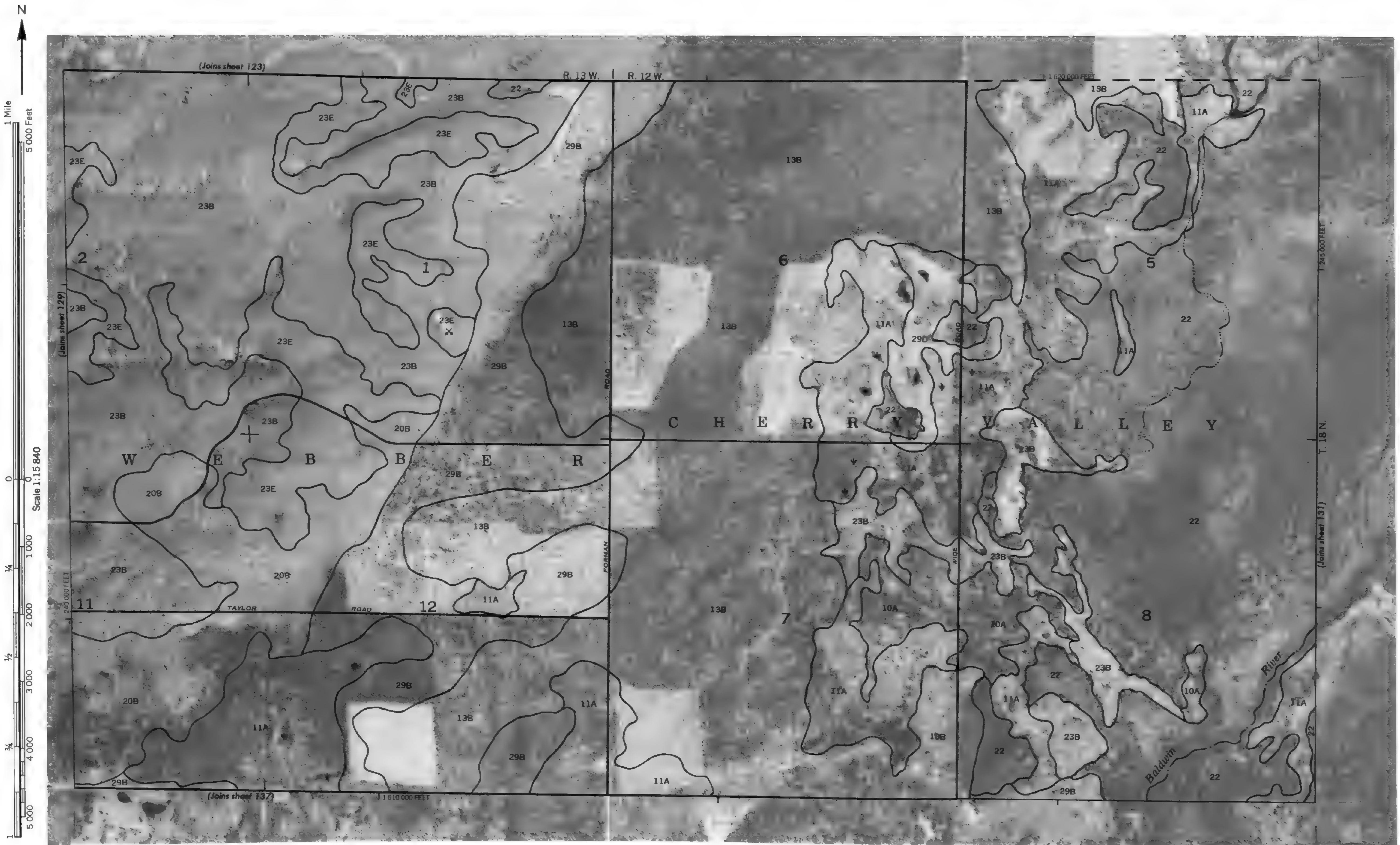
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 13

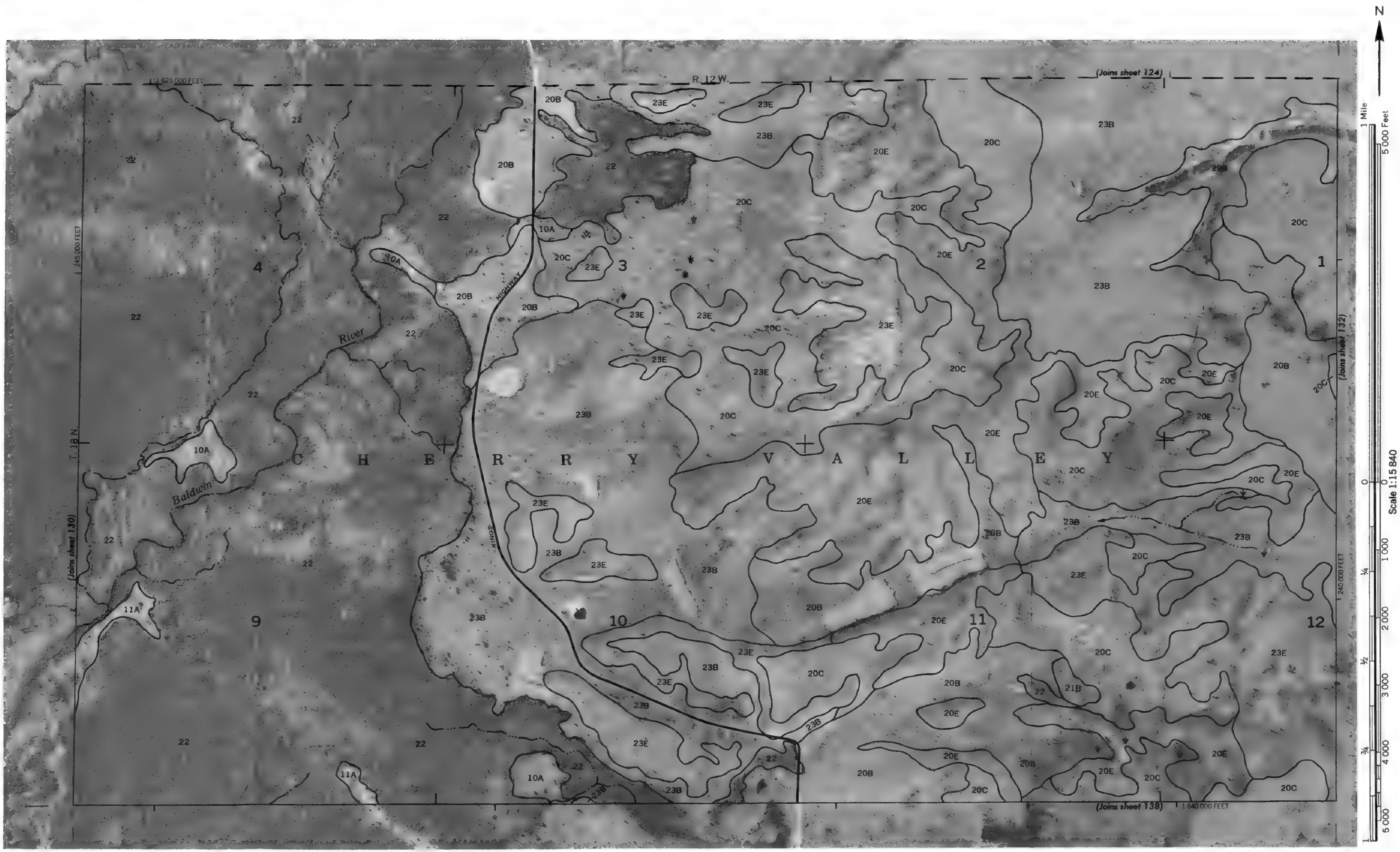
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(130)



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

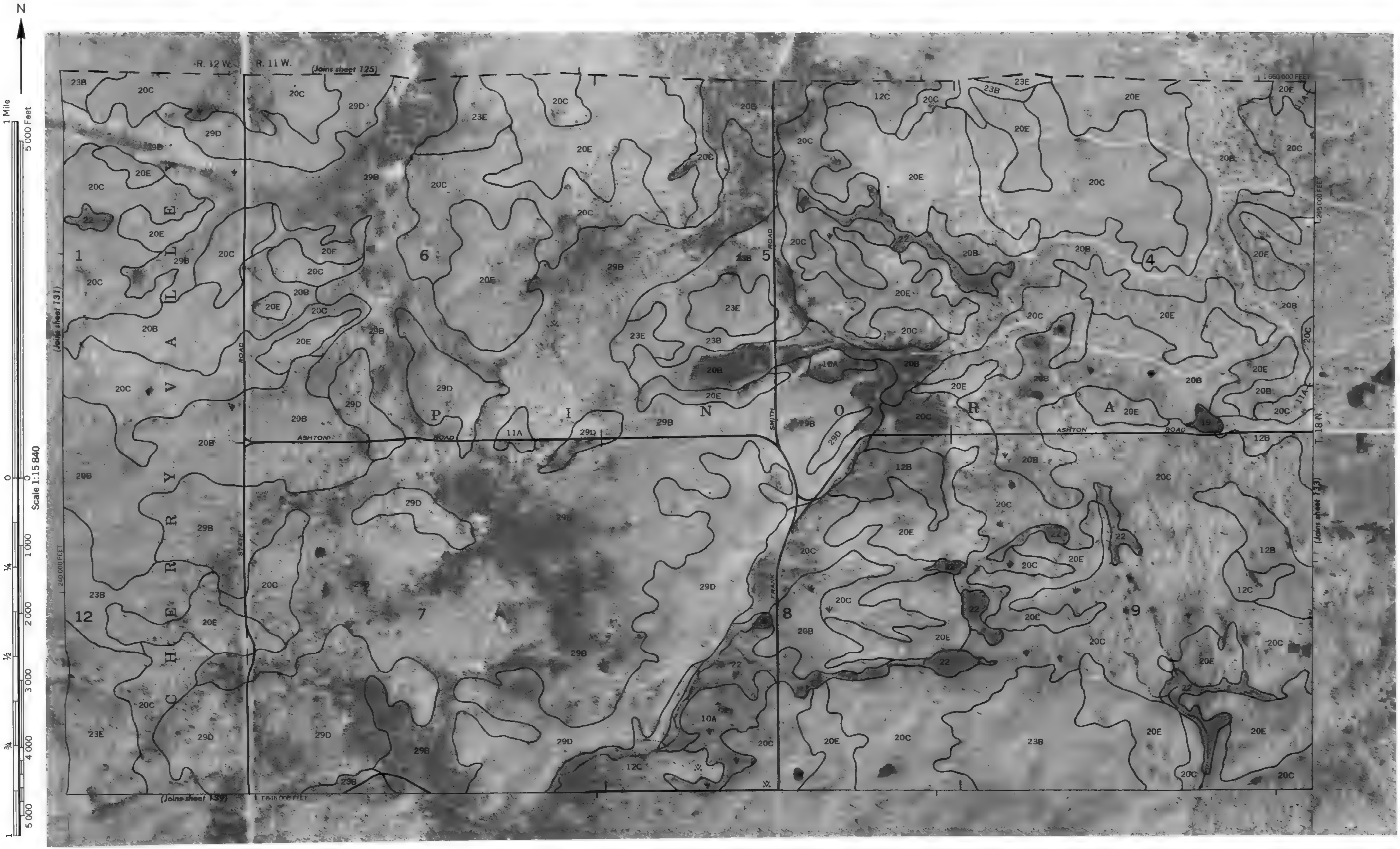
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 130



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 131

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 132

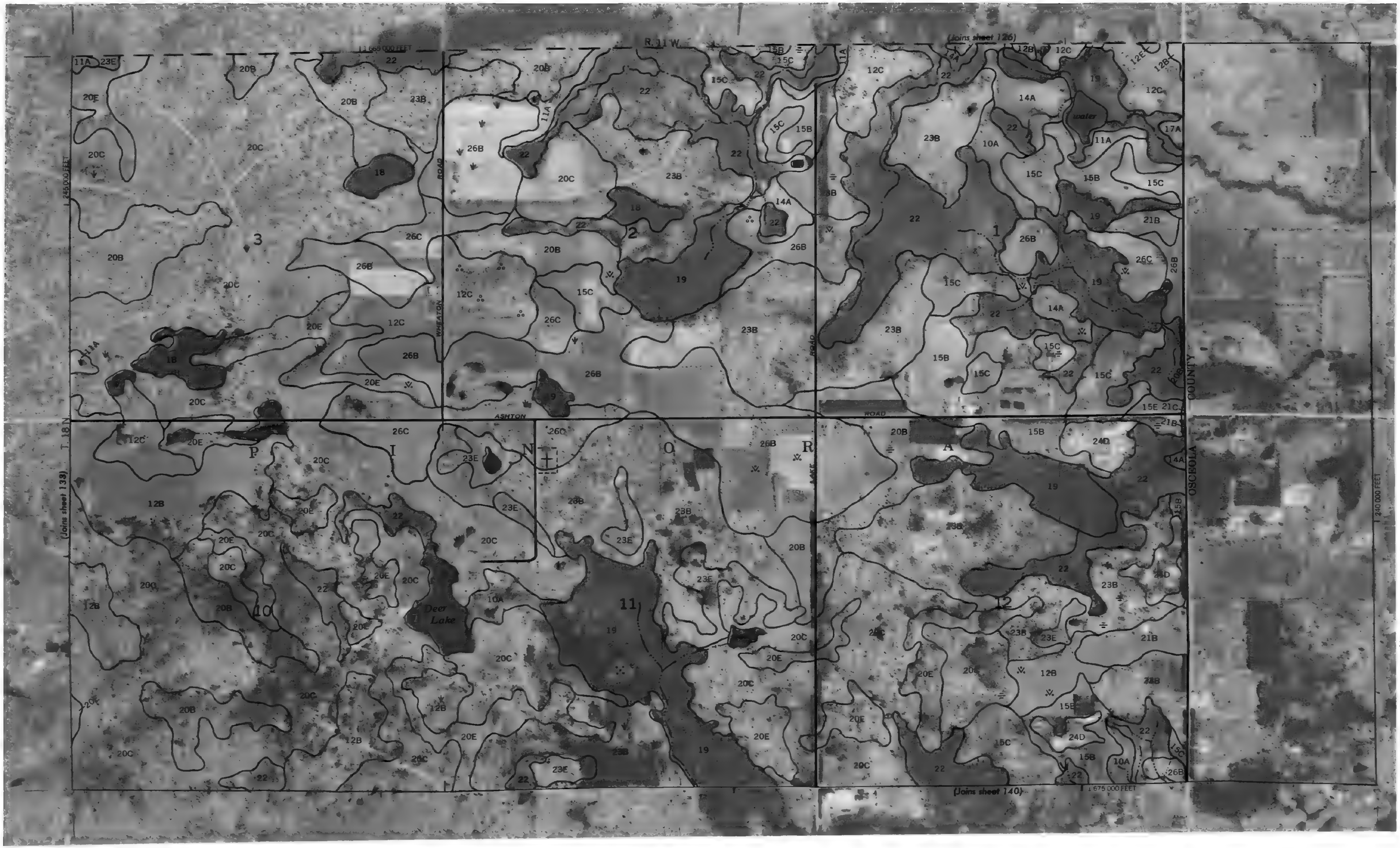


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 132

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 133

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

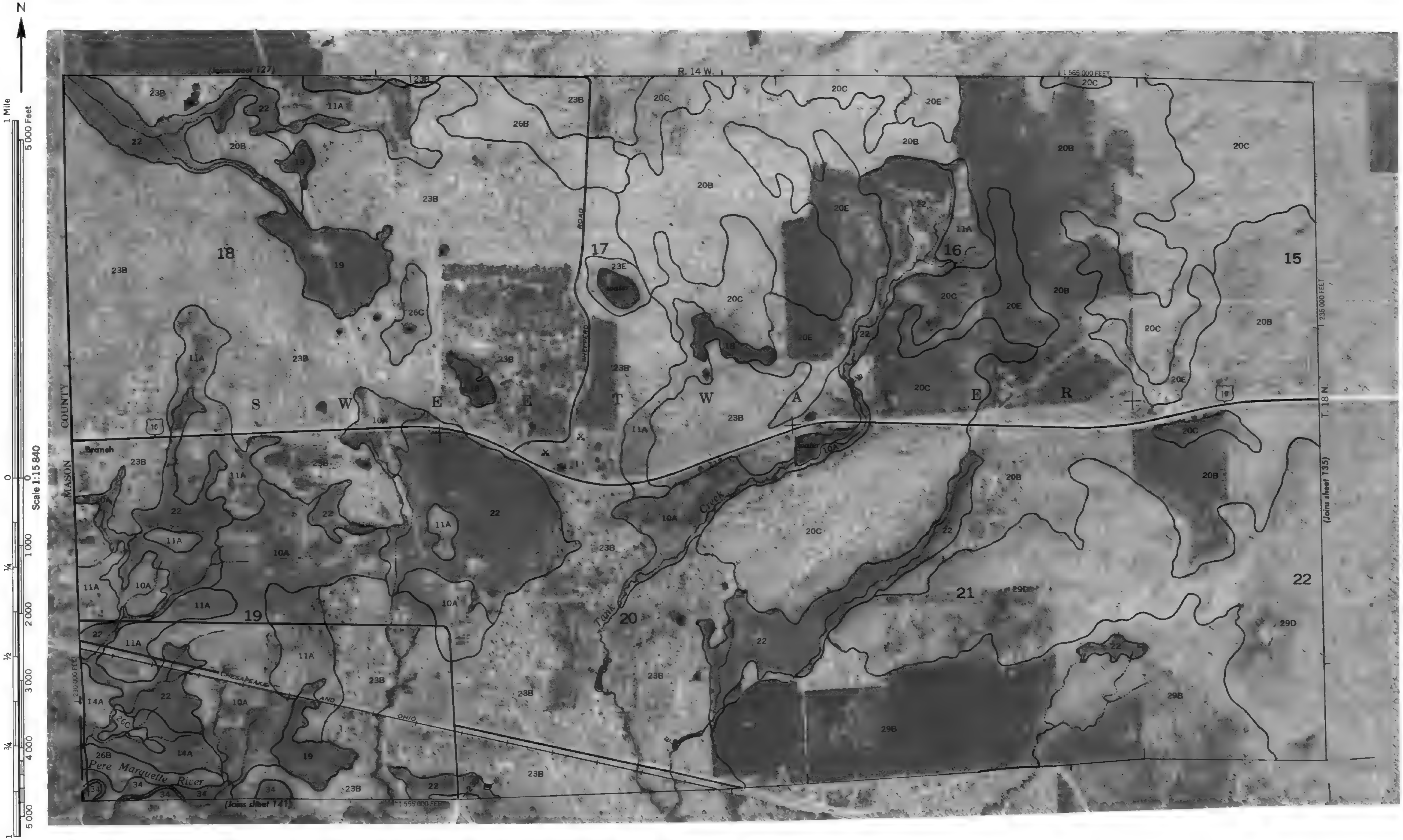


N

1 Mile

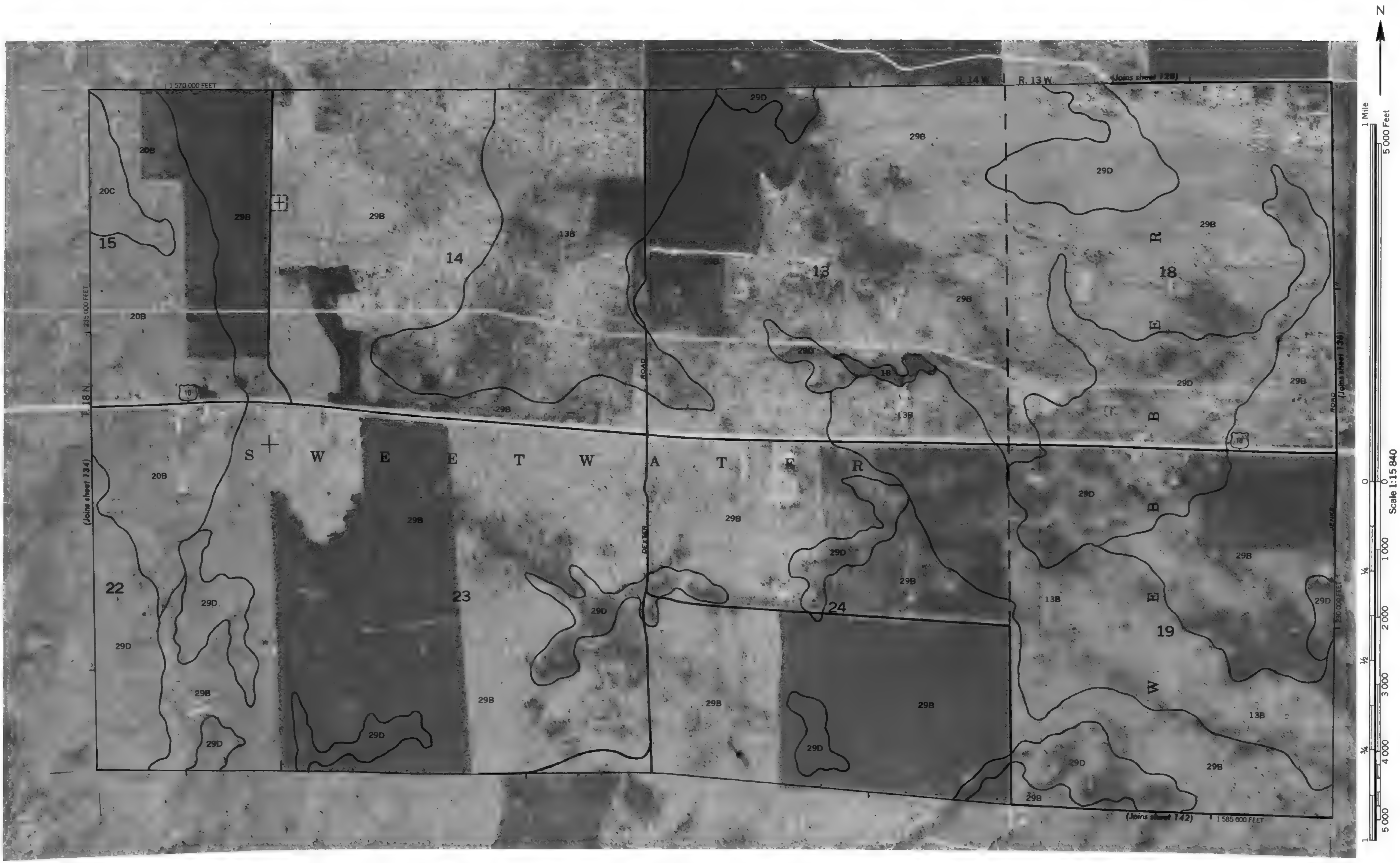
5 000 Feet

Scale 1:15 840



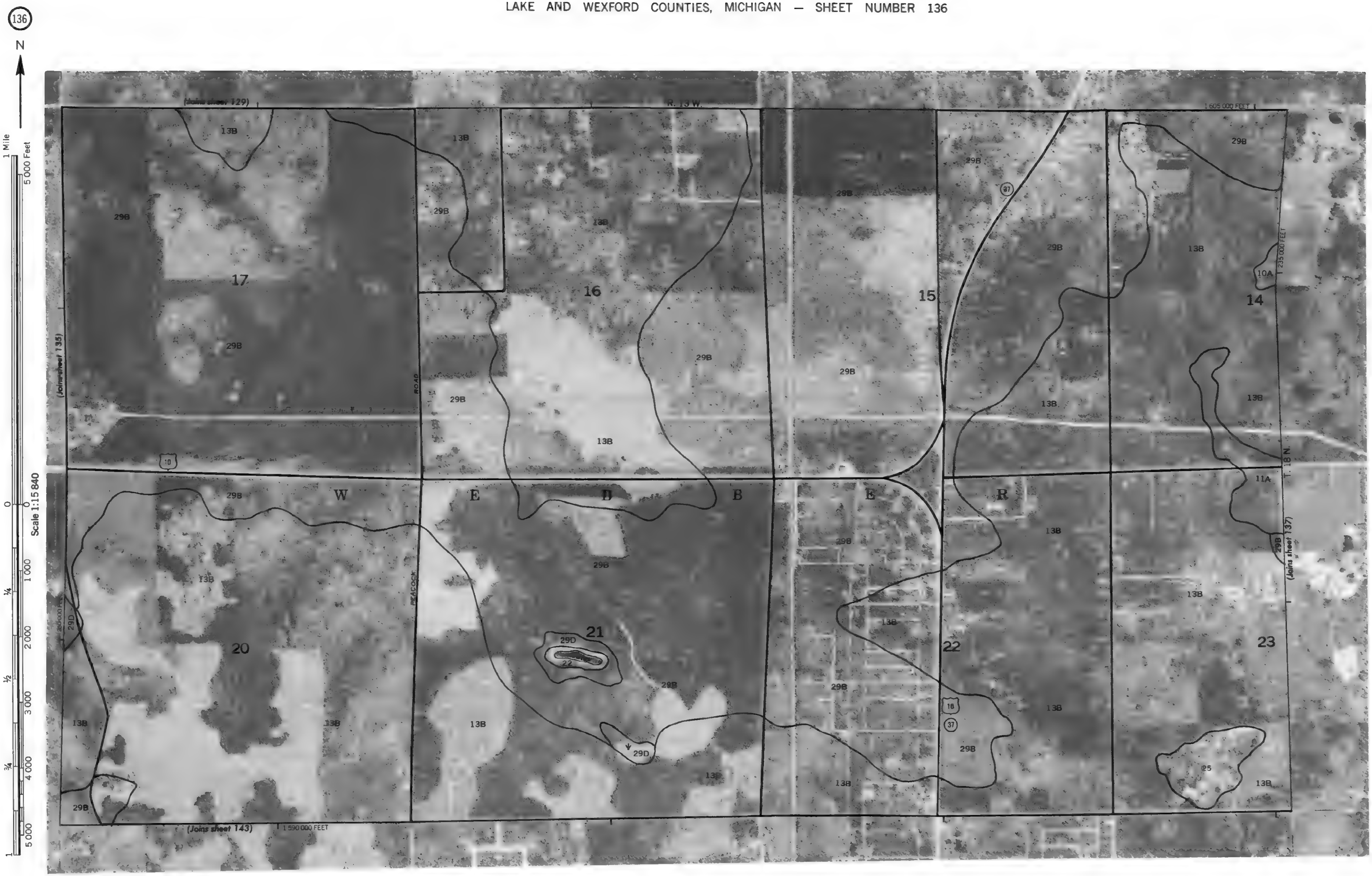
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

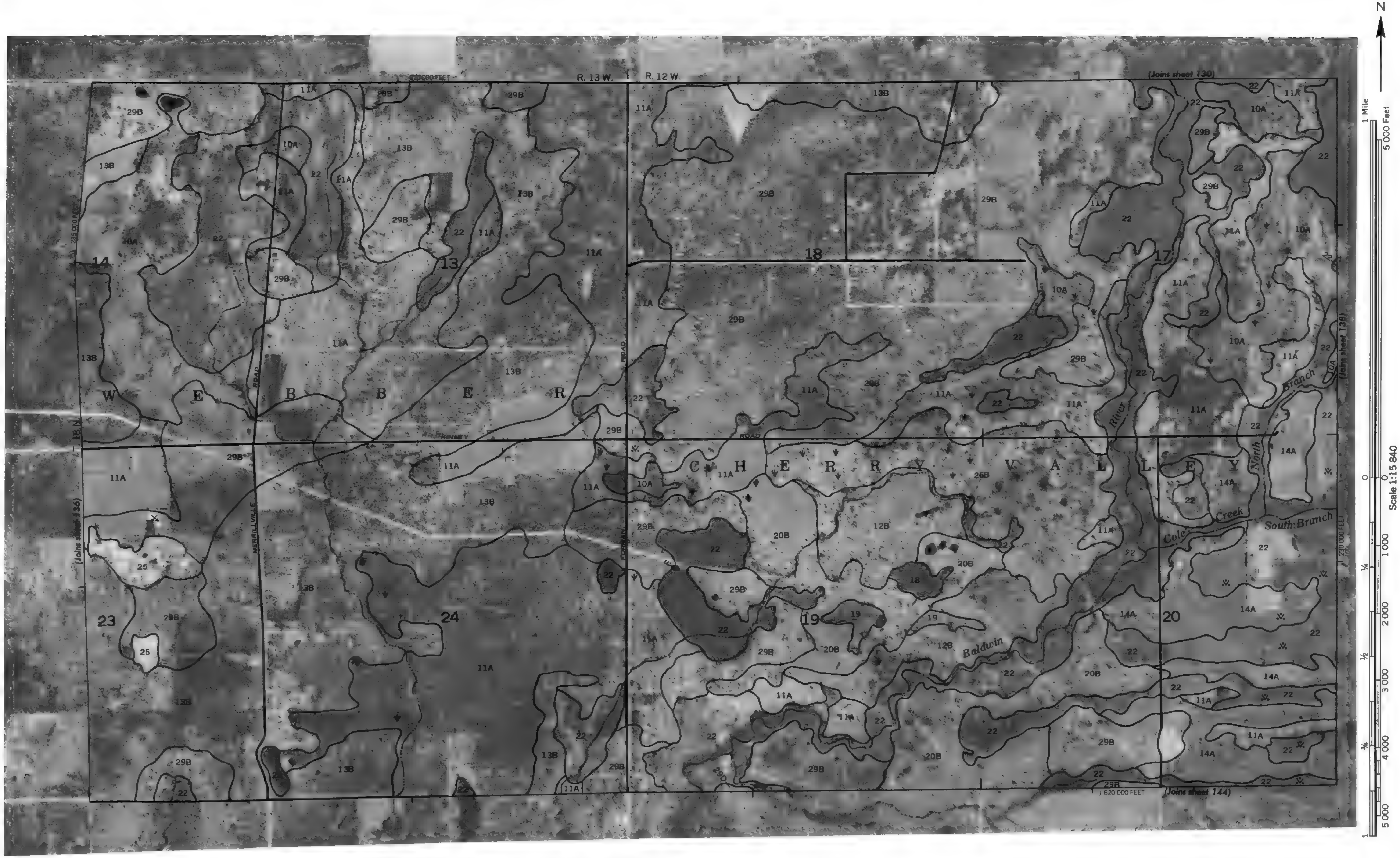
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 134



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 135

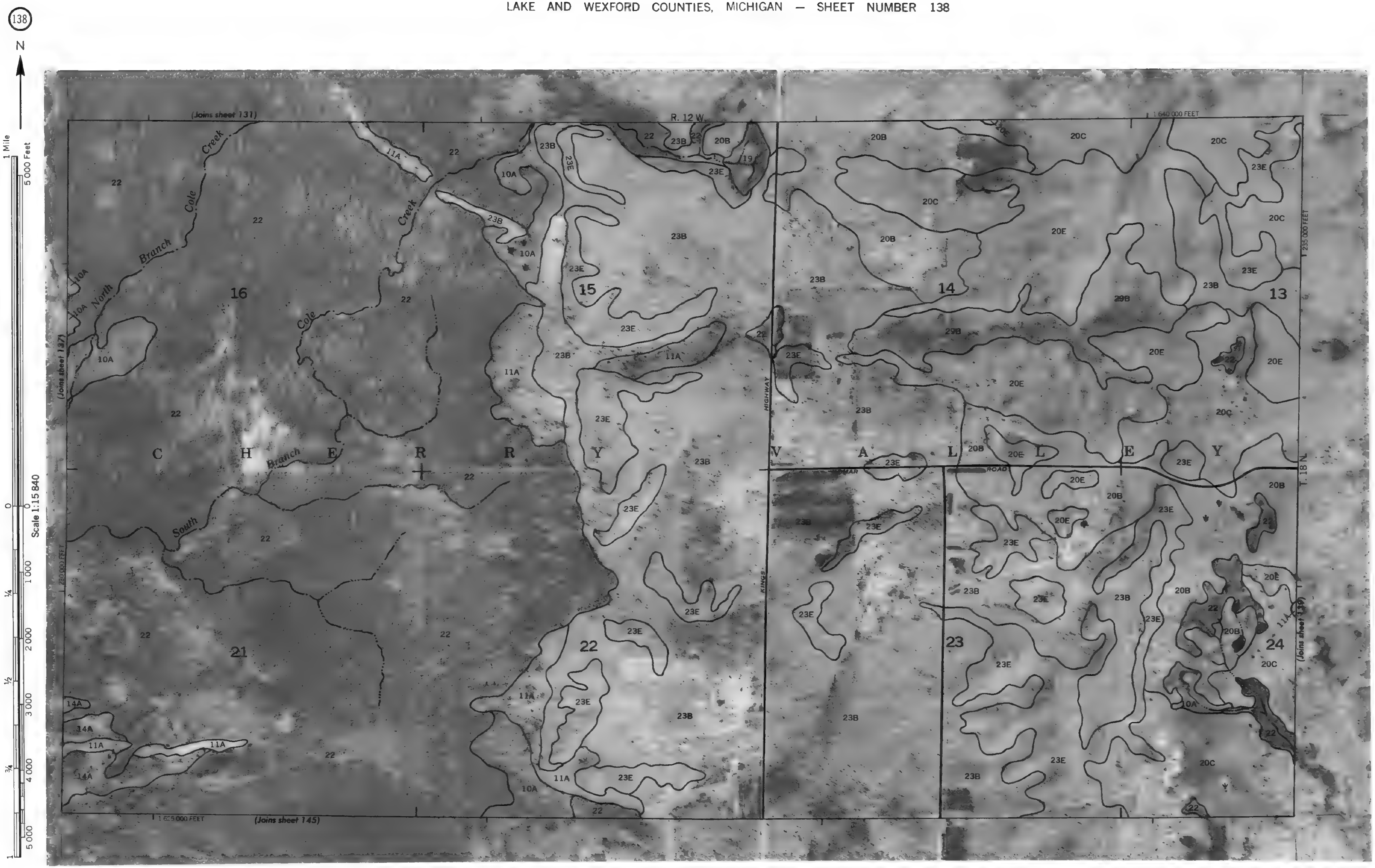
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


136
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 129)
(Joins sheet 135)
(Joins sheet 137)
(Joins sheet 143)
R. 13 W.
T. 18 N.
1 605 000 FEET
235 000 FEET
1 590 000 FEET
PEACOCK ROAD
W E D B E E R
17
16
15
14
20
21
22
23
13B
29B
29D
22
10A
11A
25
10
37



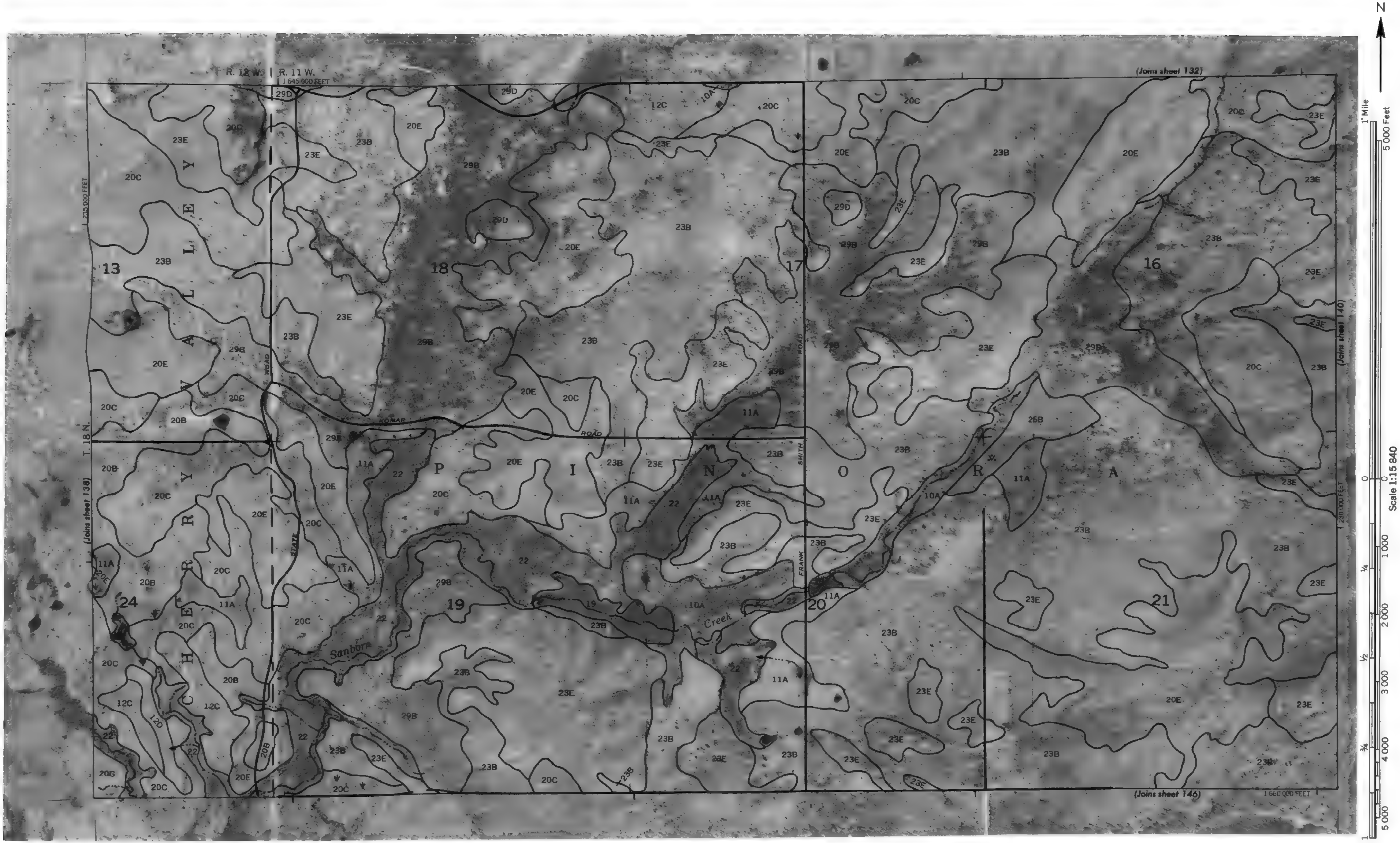
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 137

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



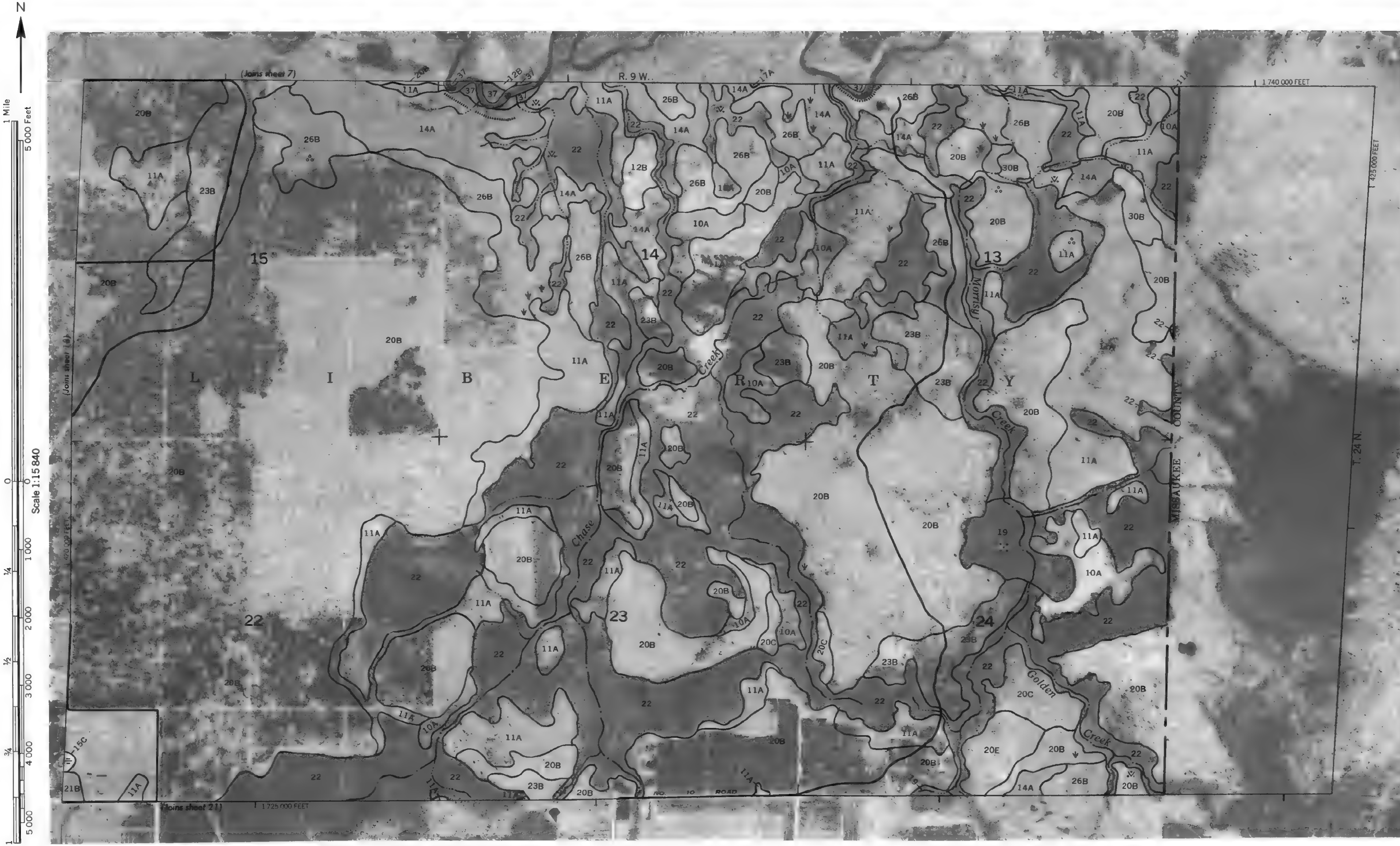
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 138

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



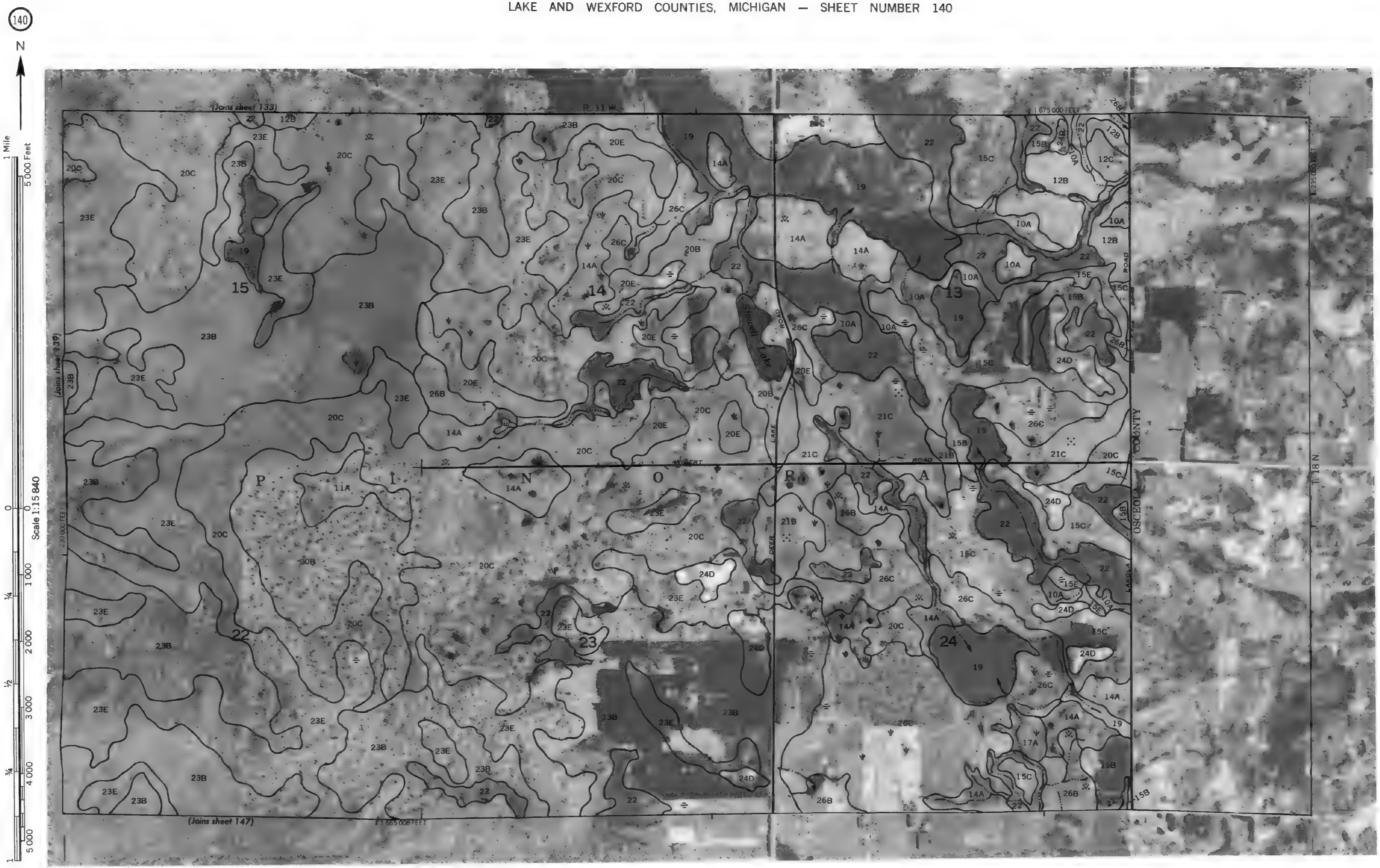
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 139

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 14



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 140

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 141

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

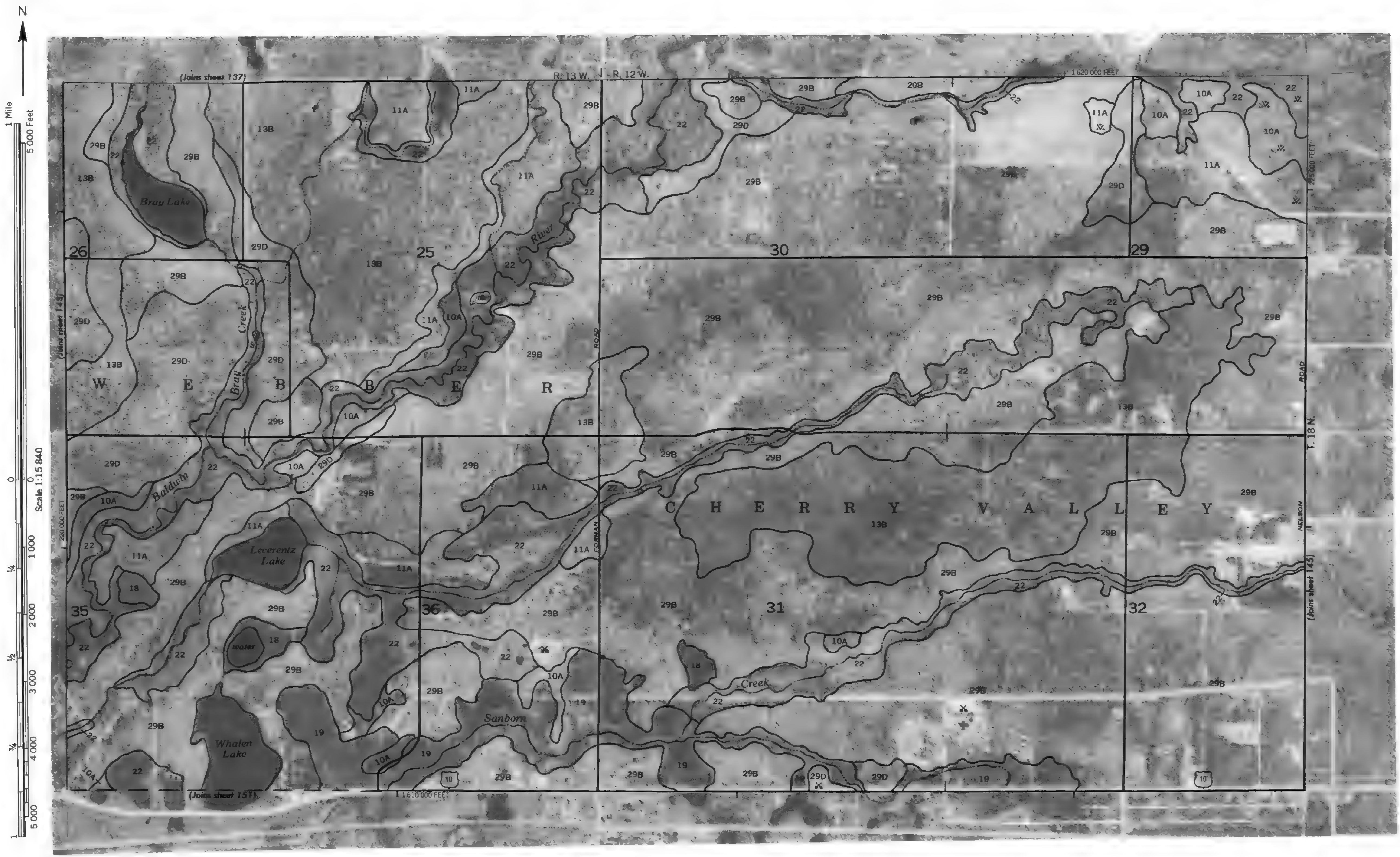
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 142

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 143

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

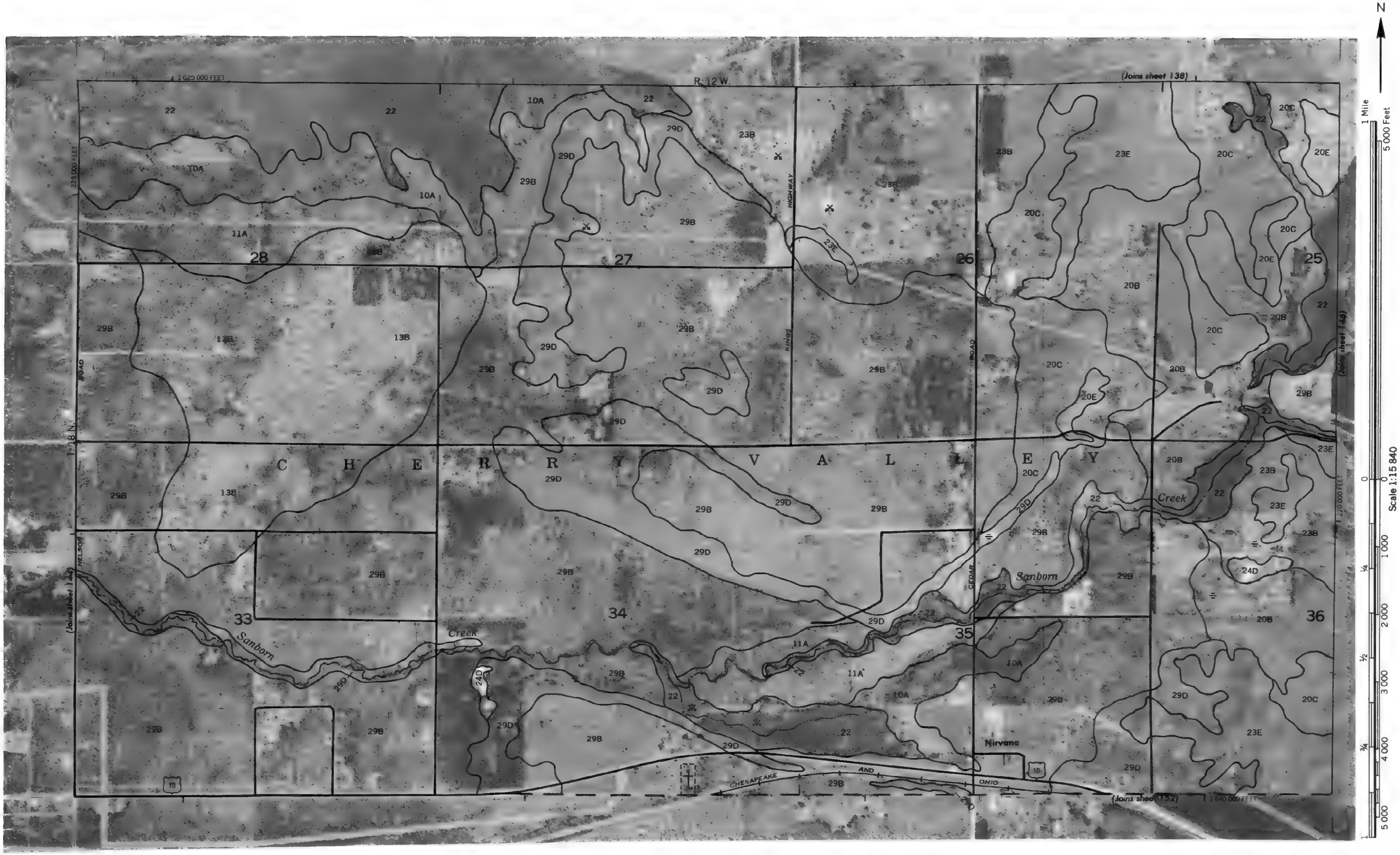
144



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

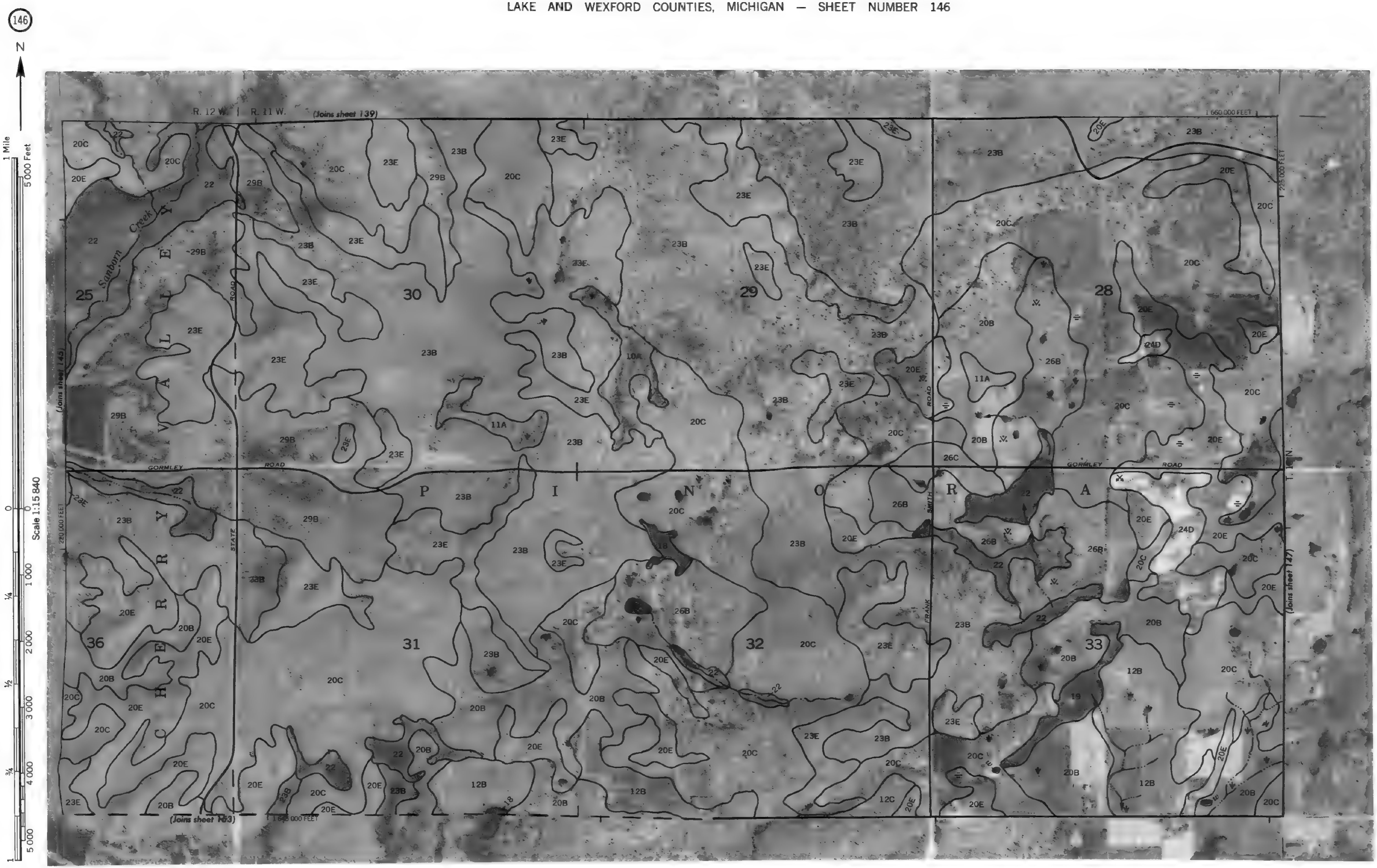
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 144

145



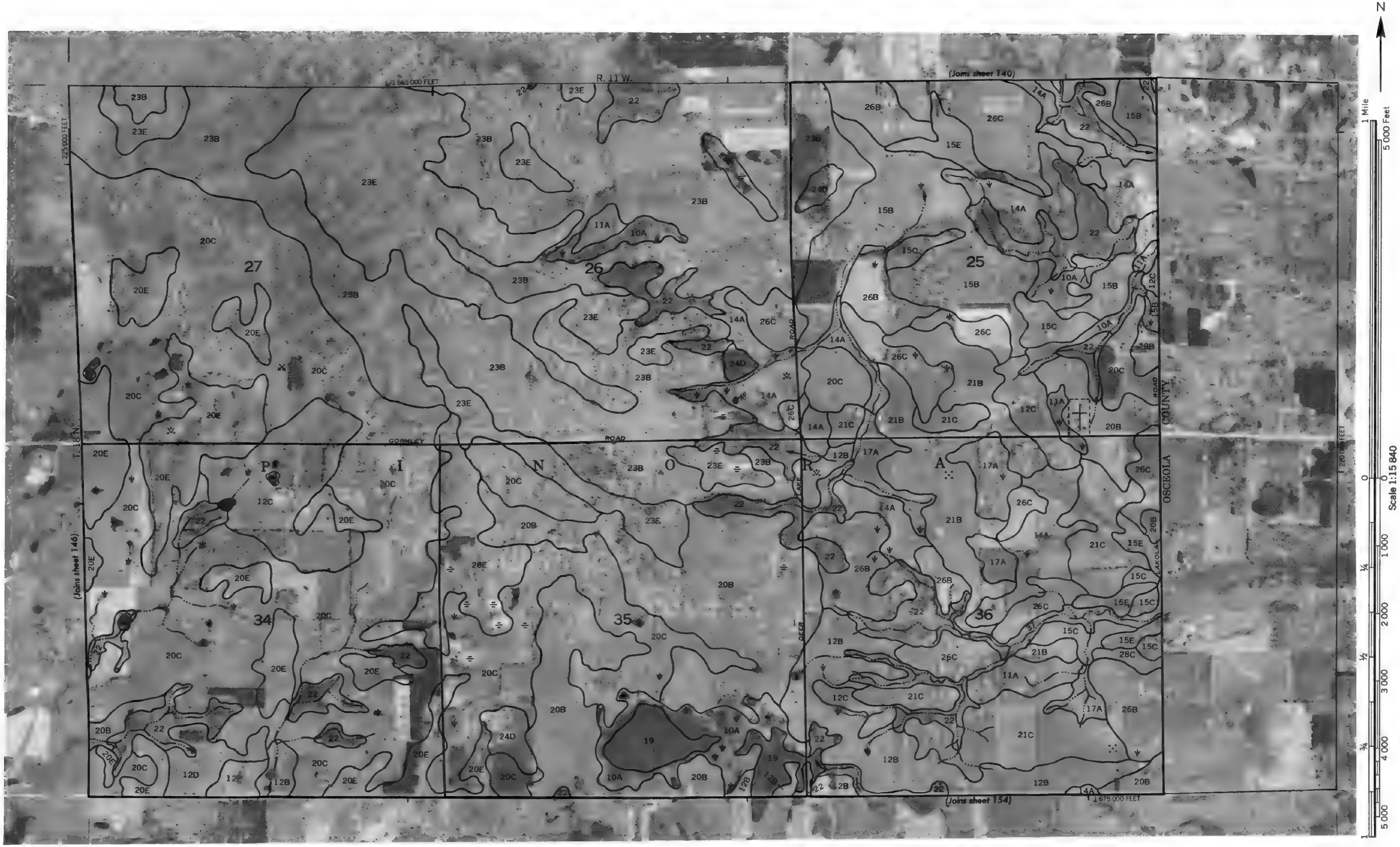
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 145

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



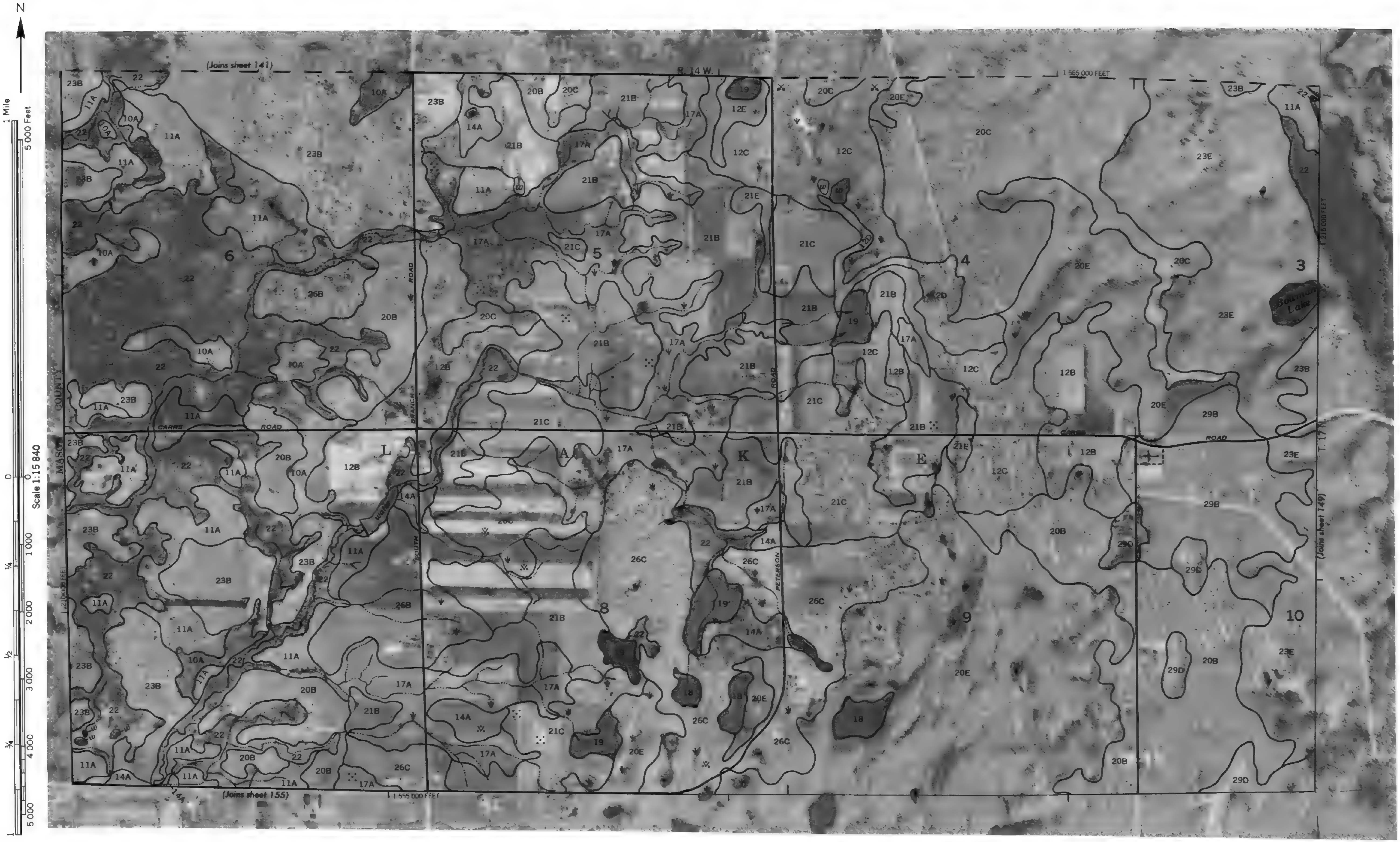
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 146

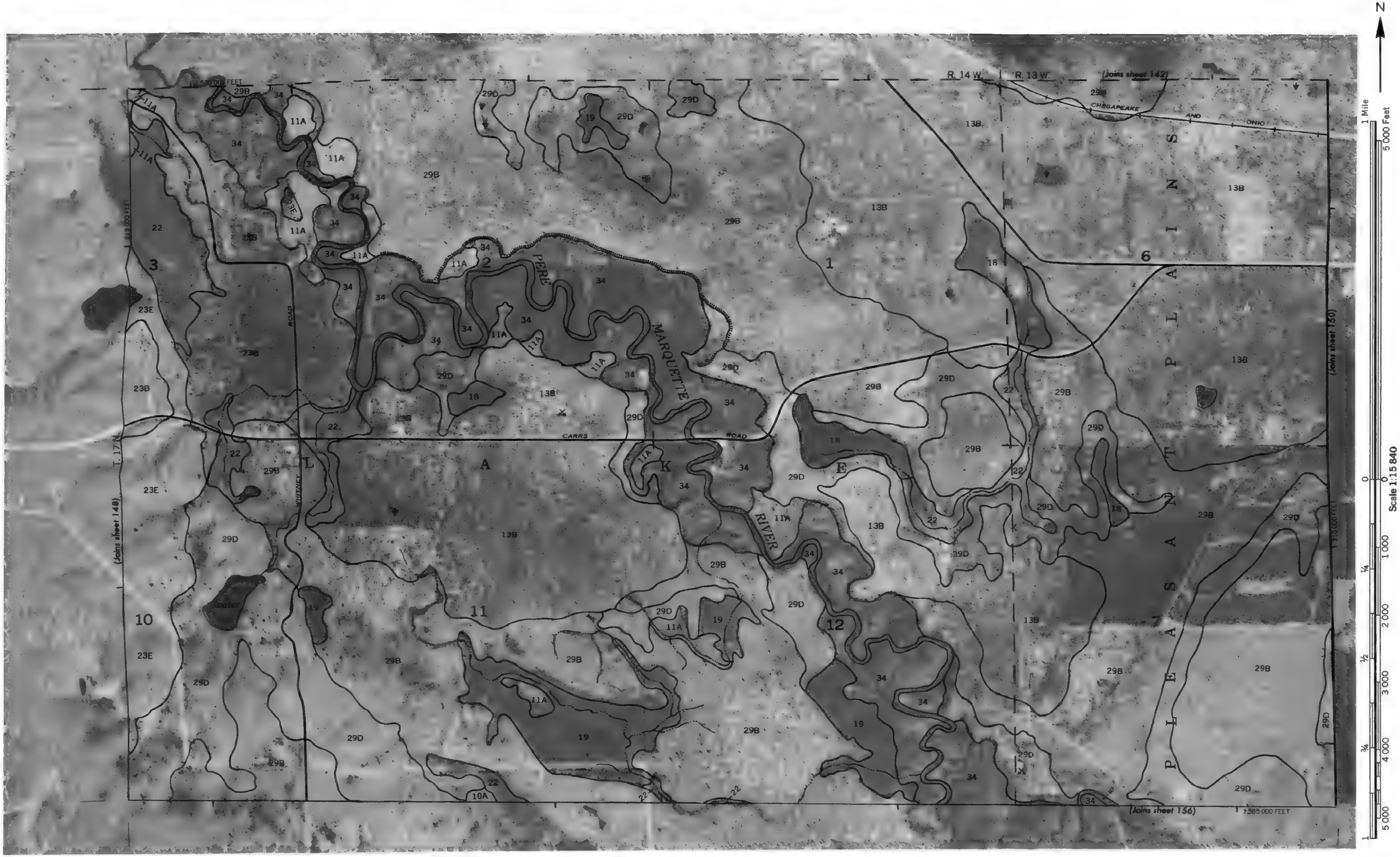


LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 147

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 149

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 15

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

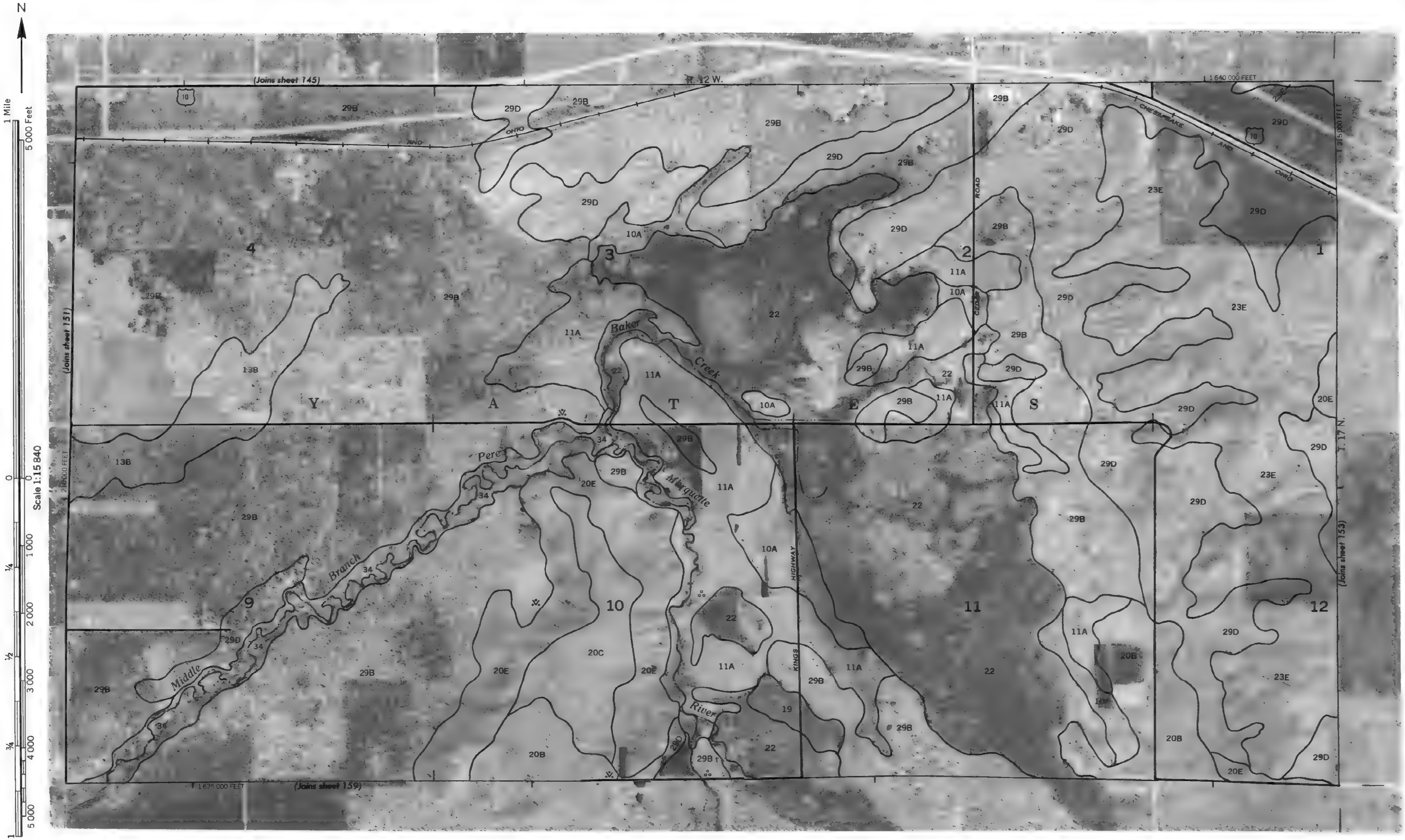
150

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 150

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 151

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



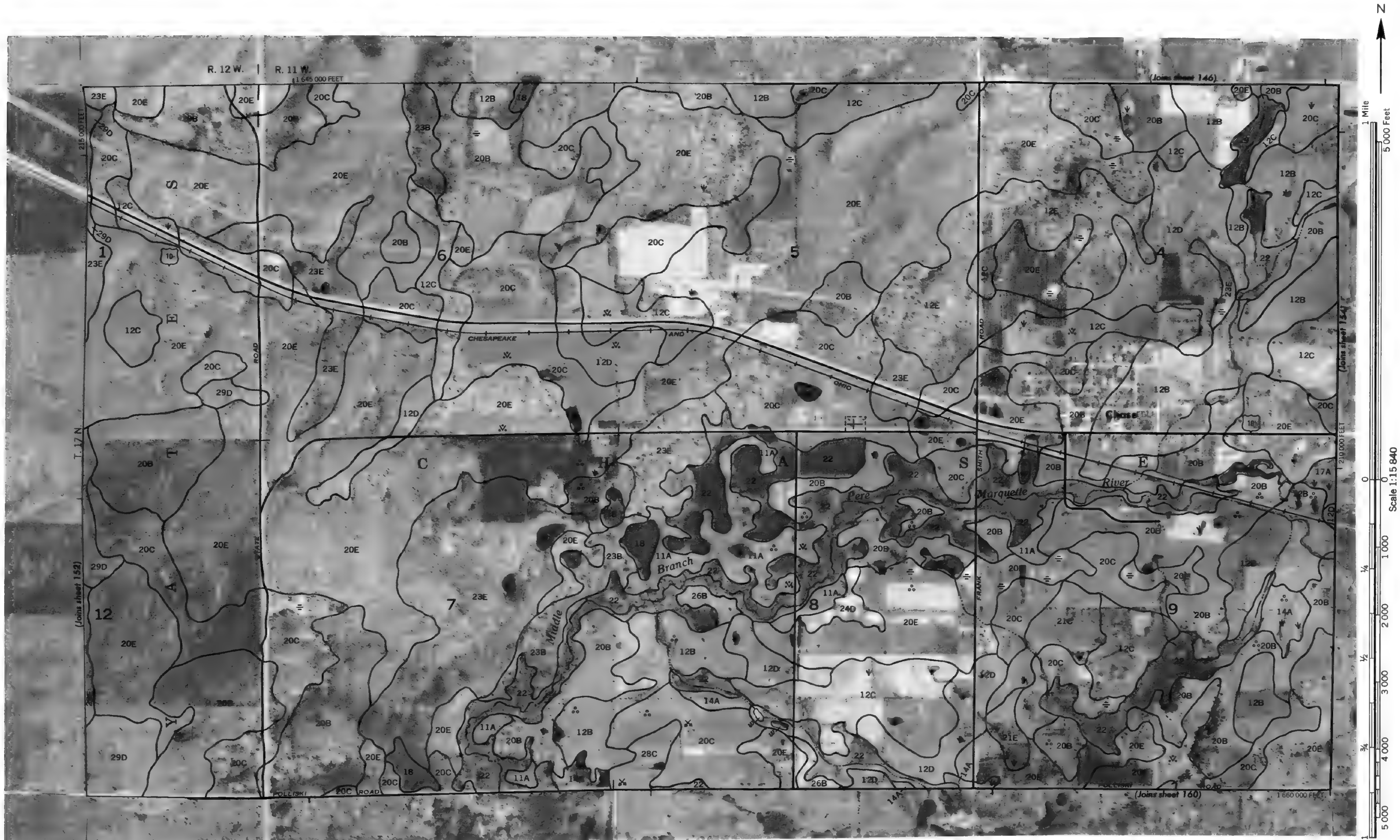
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

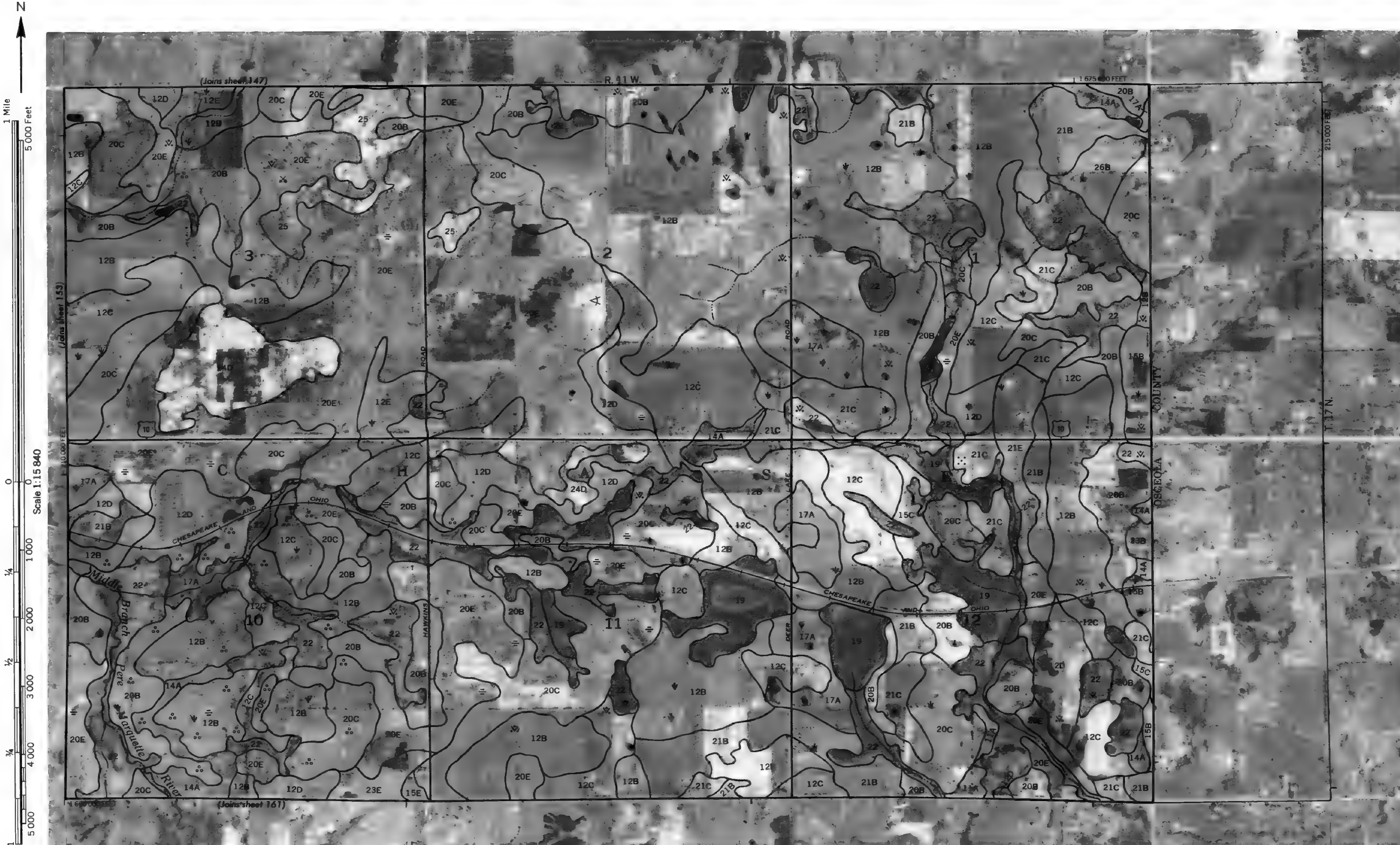
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 152

153

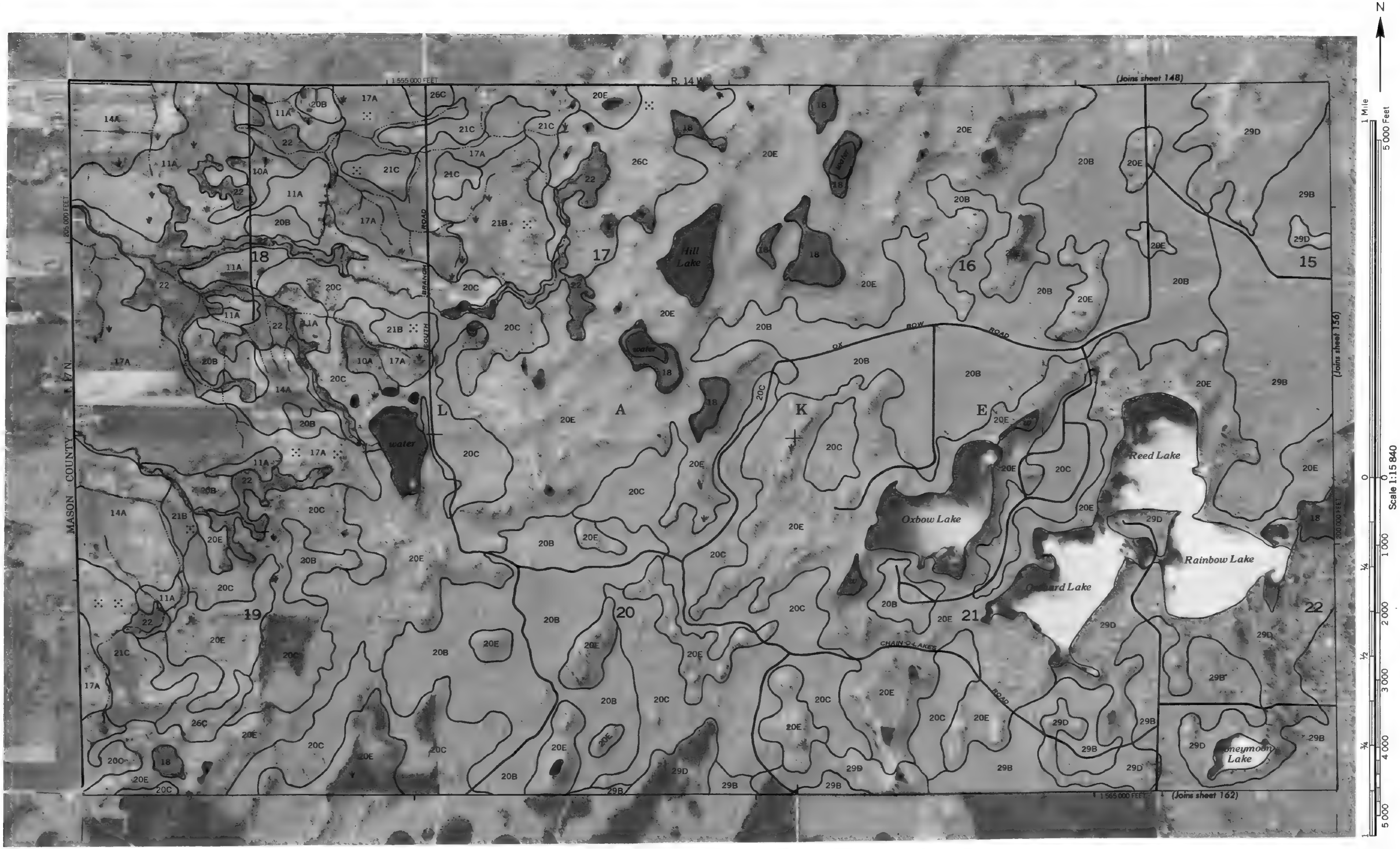
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 153

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 155

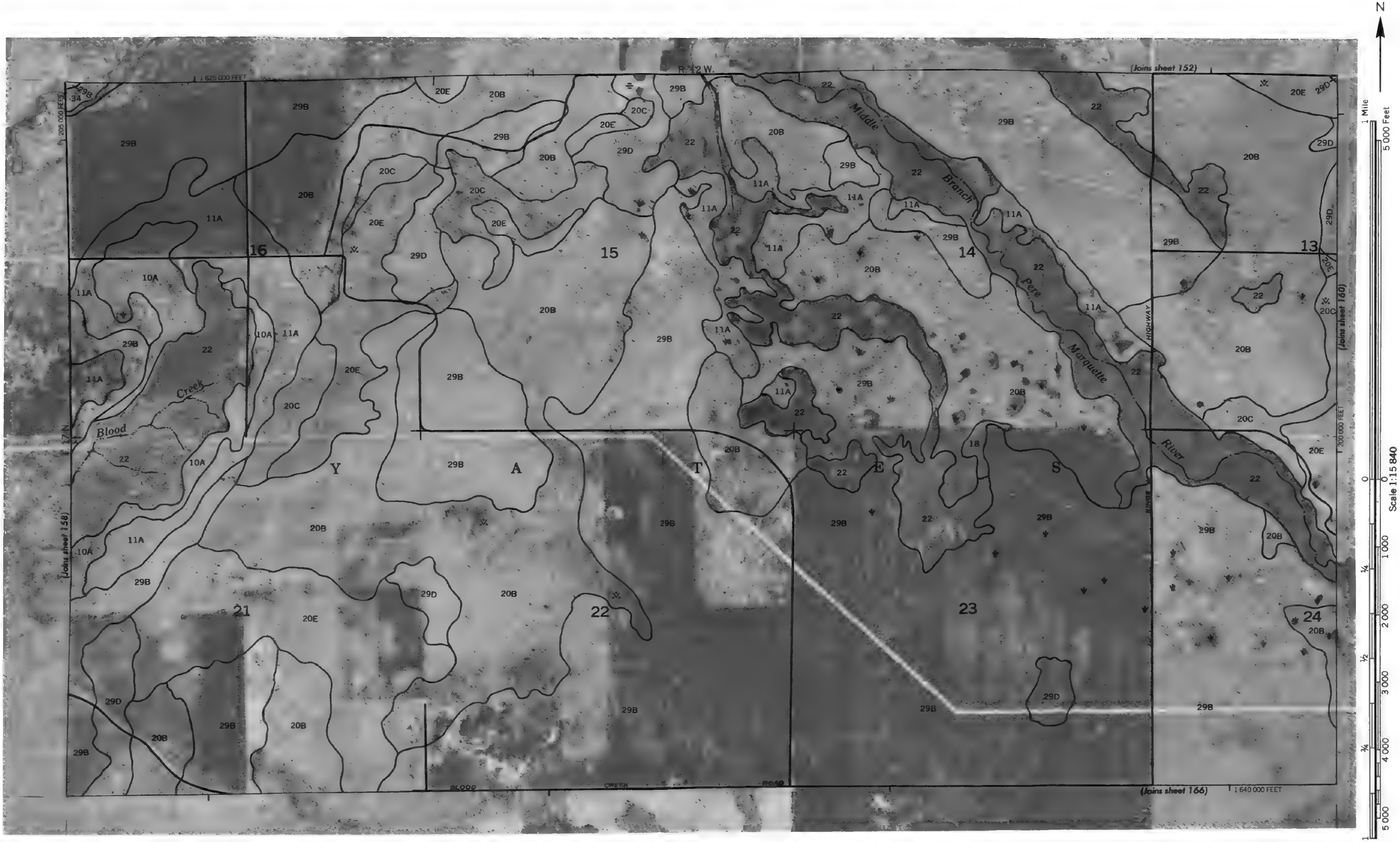
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 156


N
(Joins sheet 150)
(Joins sheet 164)
(Joins sheet 156)
(Joins sheet 158)
R. 13 W.
T. 17 N.
1 590 000 FEET
1 605 000 FEET
205 000 FEET
200 000 FEET
PERE MARQUETTE RIVER
Baldwin River
Middle Branch Pere Marquette River
South Branch Pere Marquette River
Danaher Creek
Jenks Creek
North Lake
North Pond
PLEASANT PLAINS
STAR LAKE ROAD
CHESAPEAKE AND OHIO
14
15
16
17
20
21
22
23
Scale 1:15 840
1 Mile
5 000 Feet
1 000
2 000
3 000
4 000
5 000
0
1/4
1/2
3/4
1


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 151)
R. 13 W.
R. 12 W.
1 620 000 FEET
205 000 FEET
200 000 FEET
1 605 000 FEET
(Joins sheet 157)
(Joins sheet 159)
(Joins sheet 165)
T. 17 N.
North Lake
Spruce Lake
water
Middle Branch
Pere Marquette River
Blood Creek
PLEASANT PLAINS
YATES
STAR LAKE ROAD
FORMAN ROAD
BROADWAY
14
13
18
17
23
24
19
20
11A
13B
29B
29D
22
19
18
34
10A

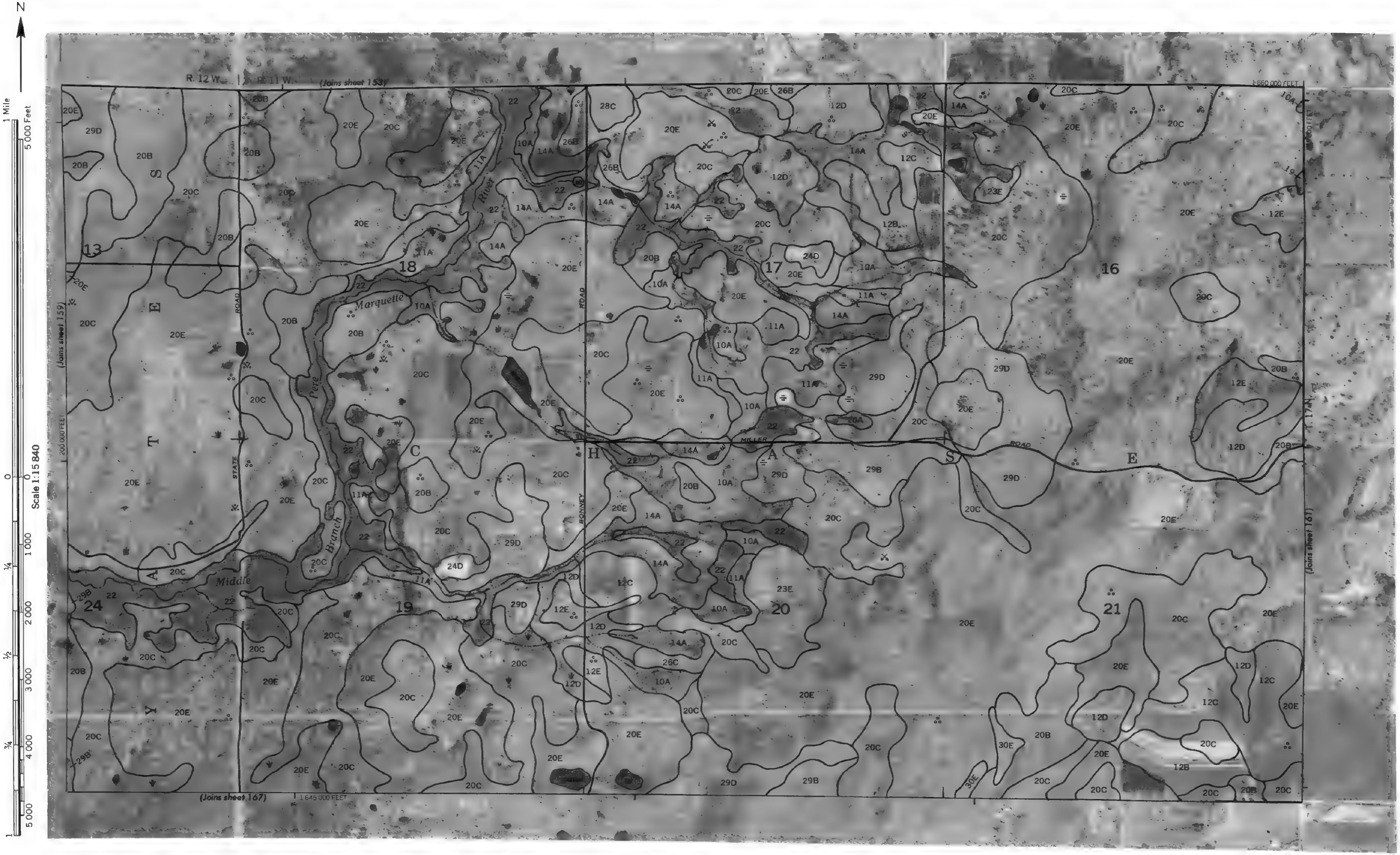


LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 159

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 16


N
1 Mile
5 000 Feet
Scale 1:15 840
R. 12 W.
R. 11 W.
(Joins sheet 153)
(Joins sheet 159)
(Joins sheet 161)
(Joins sheet 167)
1 660 000 FEET
1 645 000 FEET
200 000 FEET
13
18
17
16
24
19
20
21
Marquette
River
Pere
Middle
Branch
STATE ROAD
BONNEY ROAD
MILLER ROAD
S
E
T
A
Y
C
H
A
S
E

161

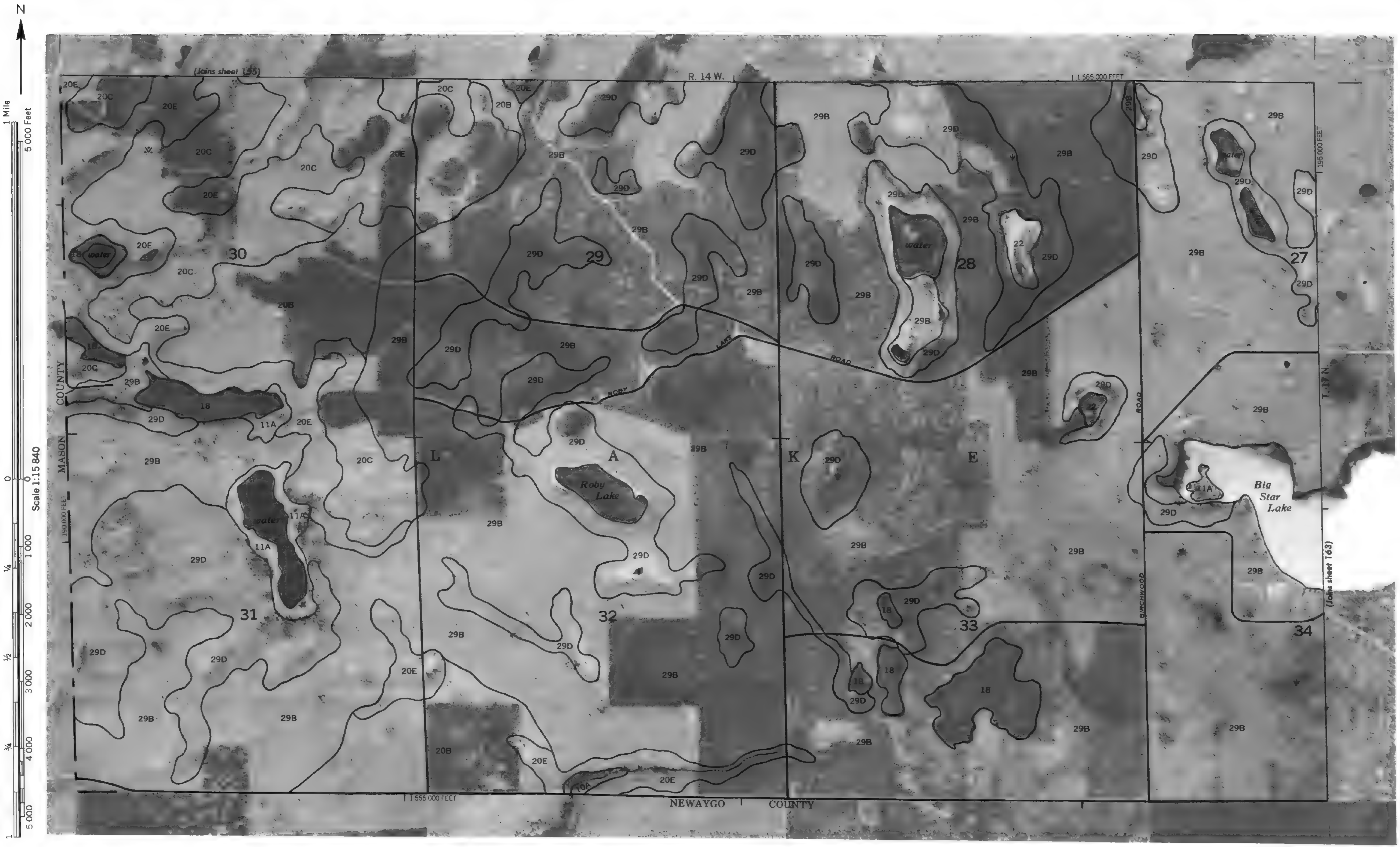
N

1 Mile
5 000 Feet
Scale 1:15 840

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 161

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 162

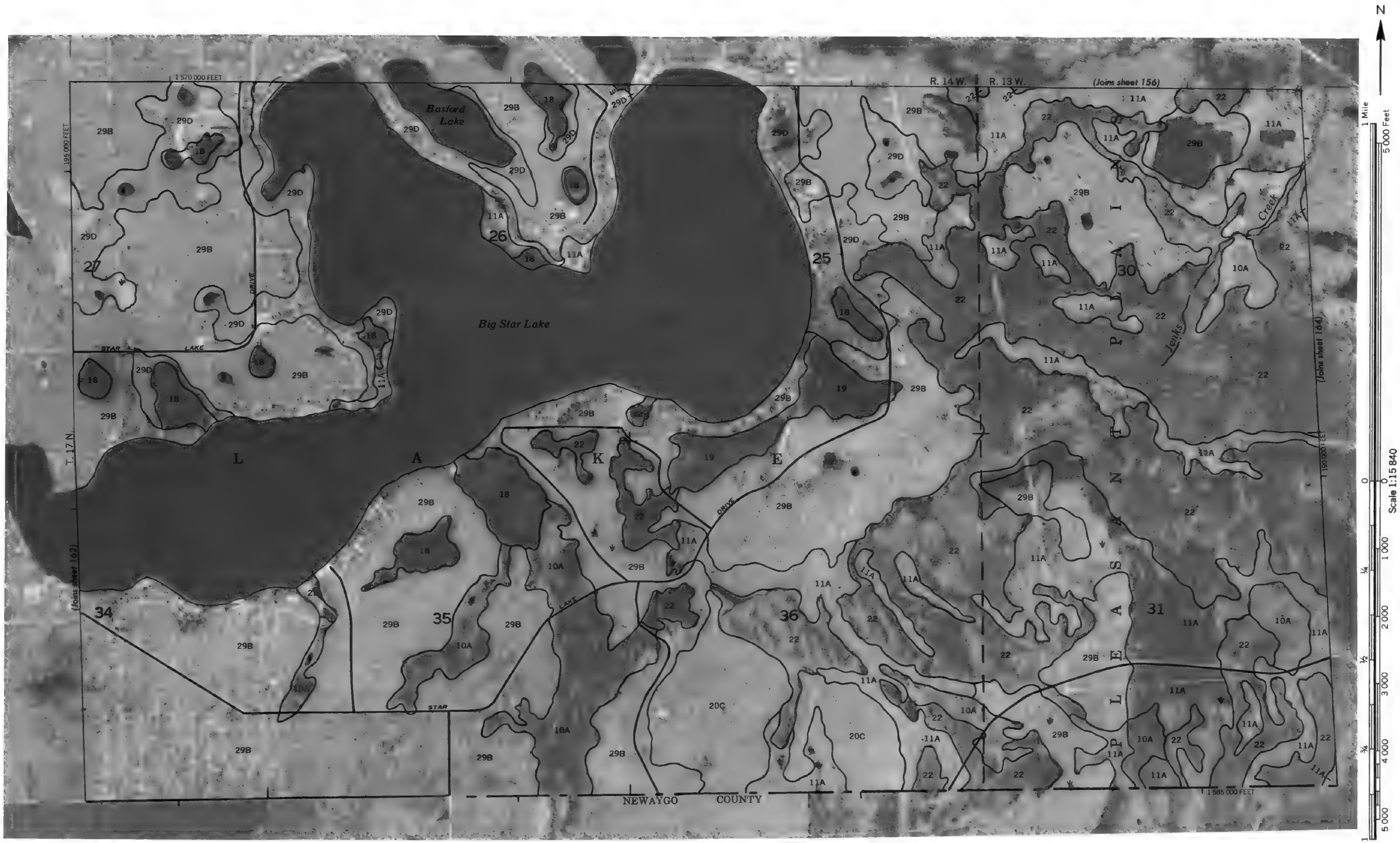


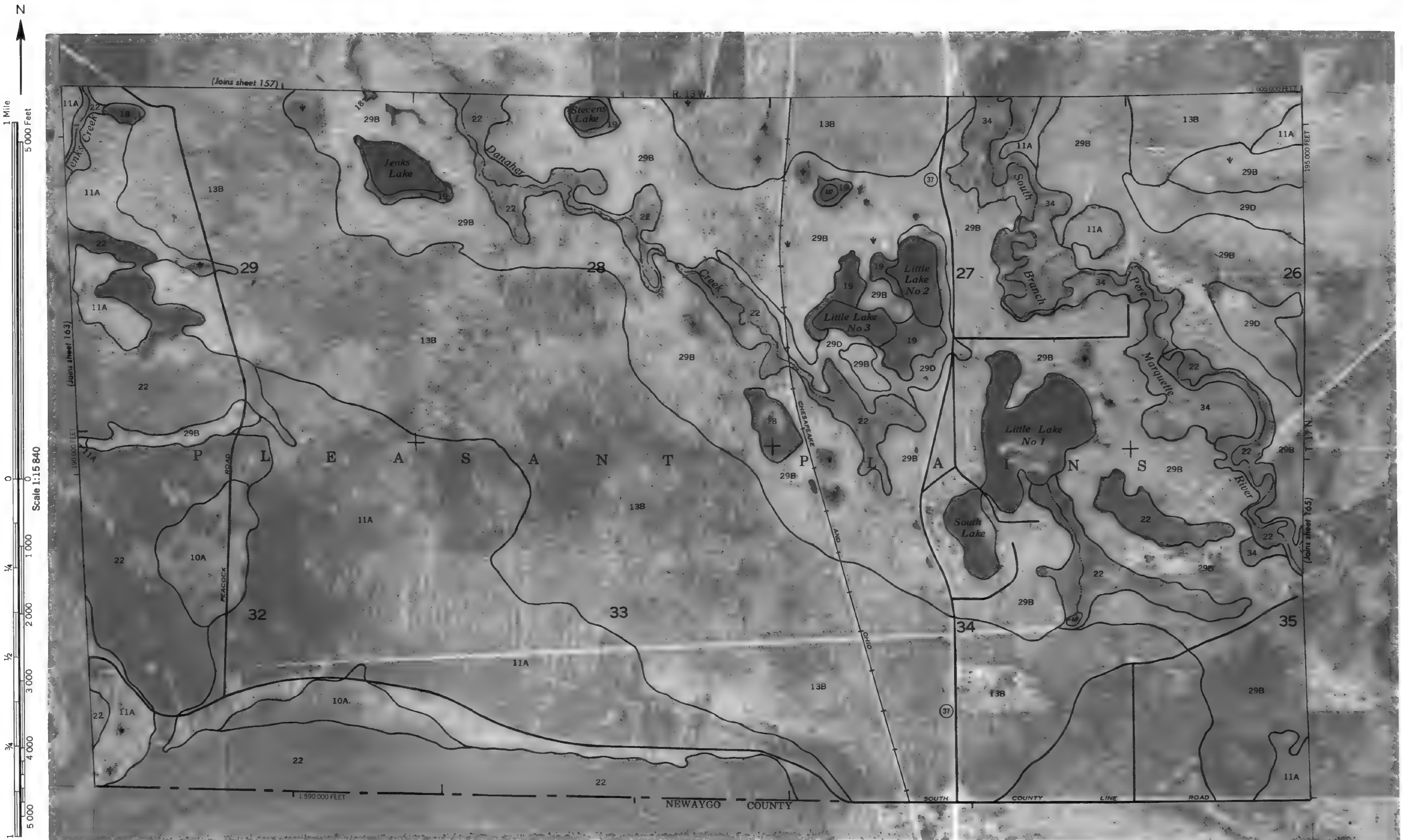
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 162

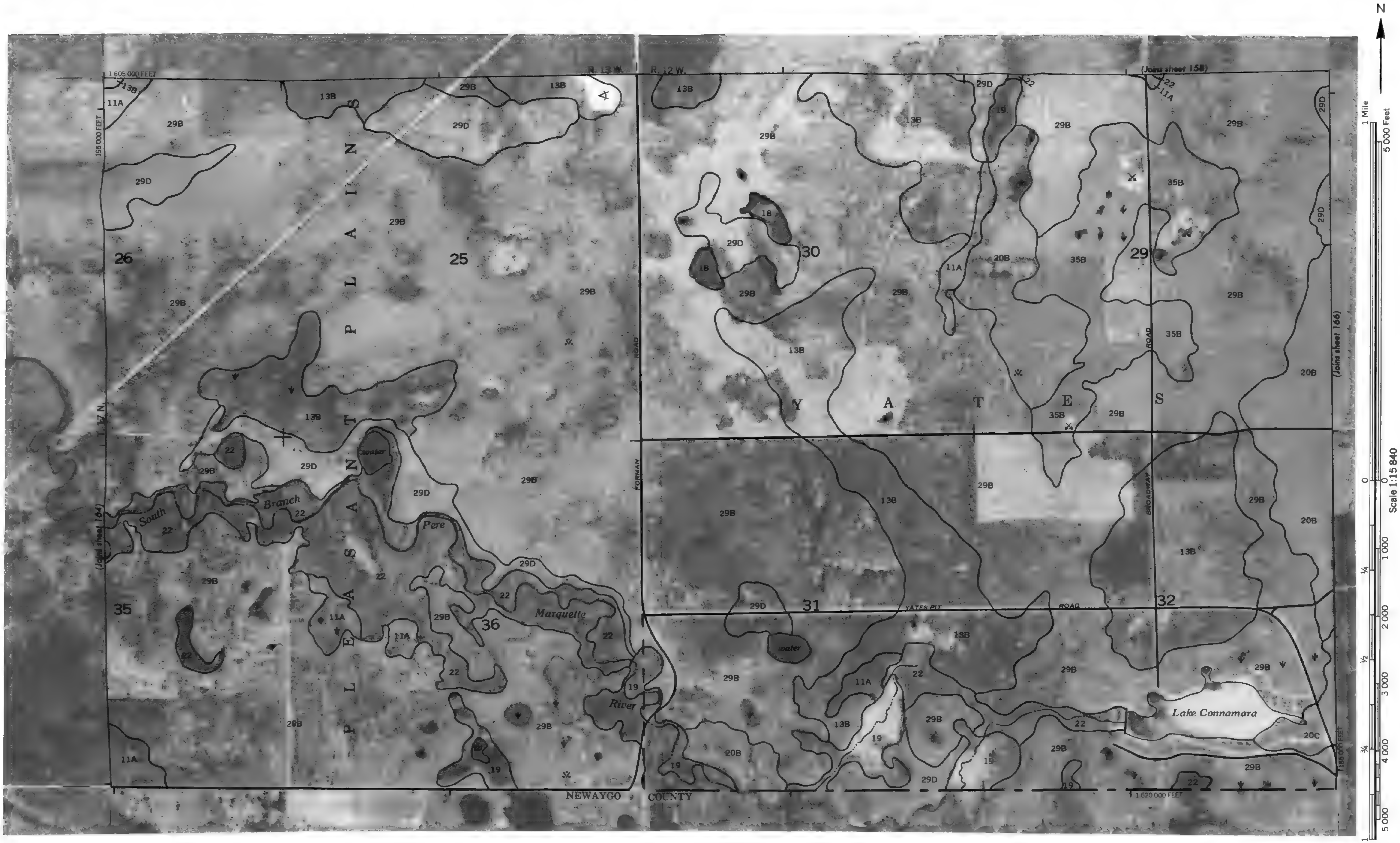
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 163

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



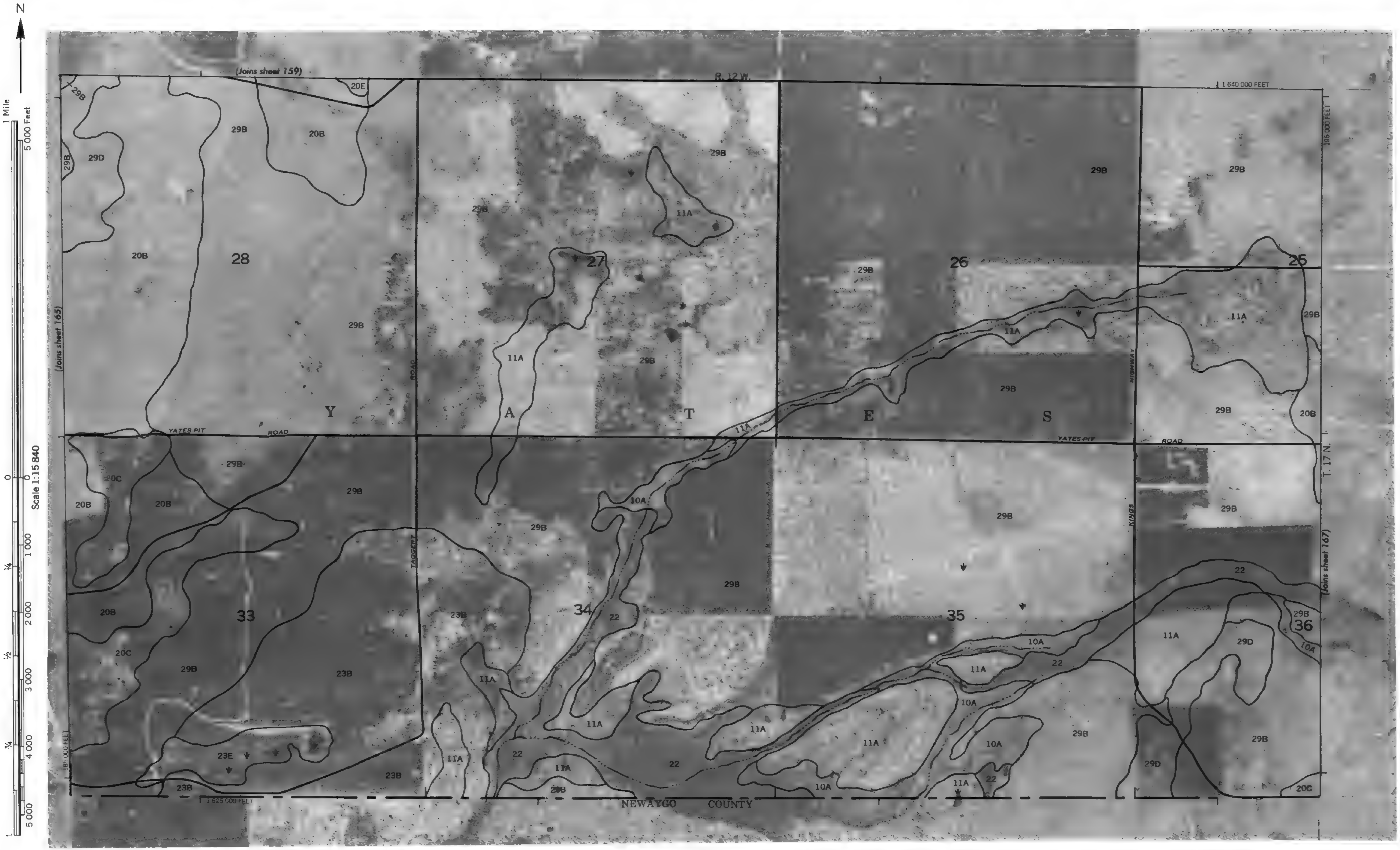


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

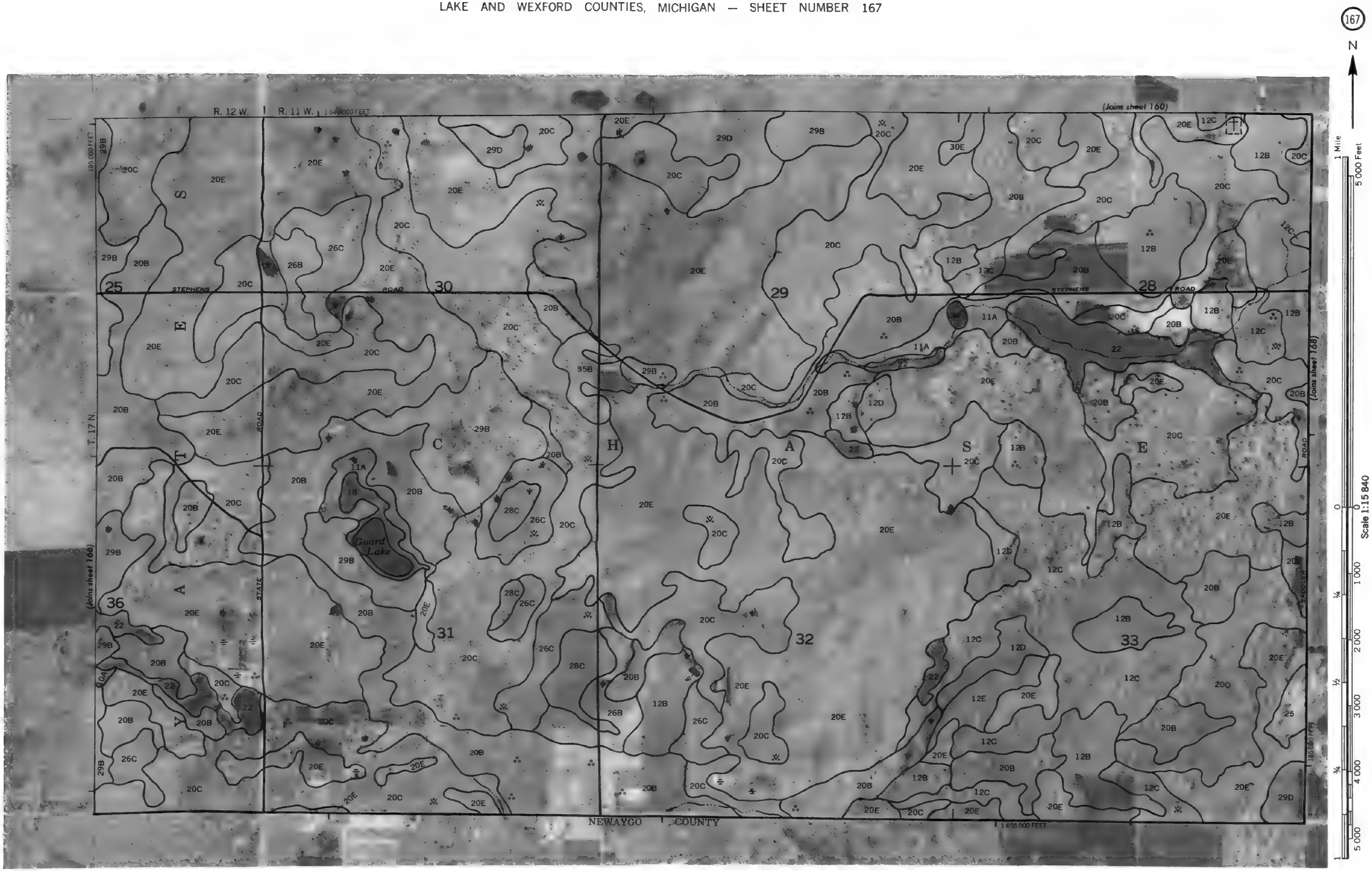


LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 165

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



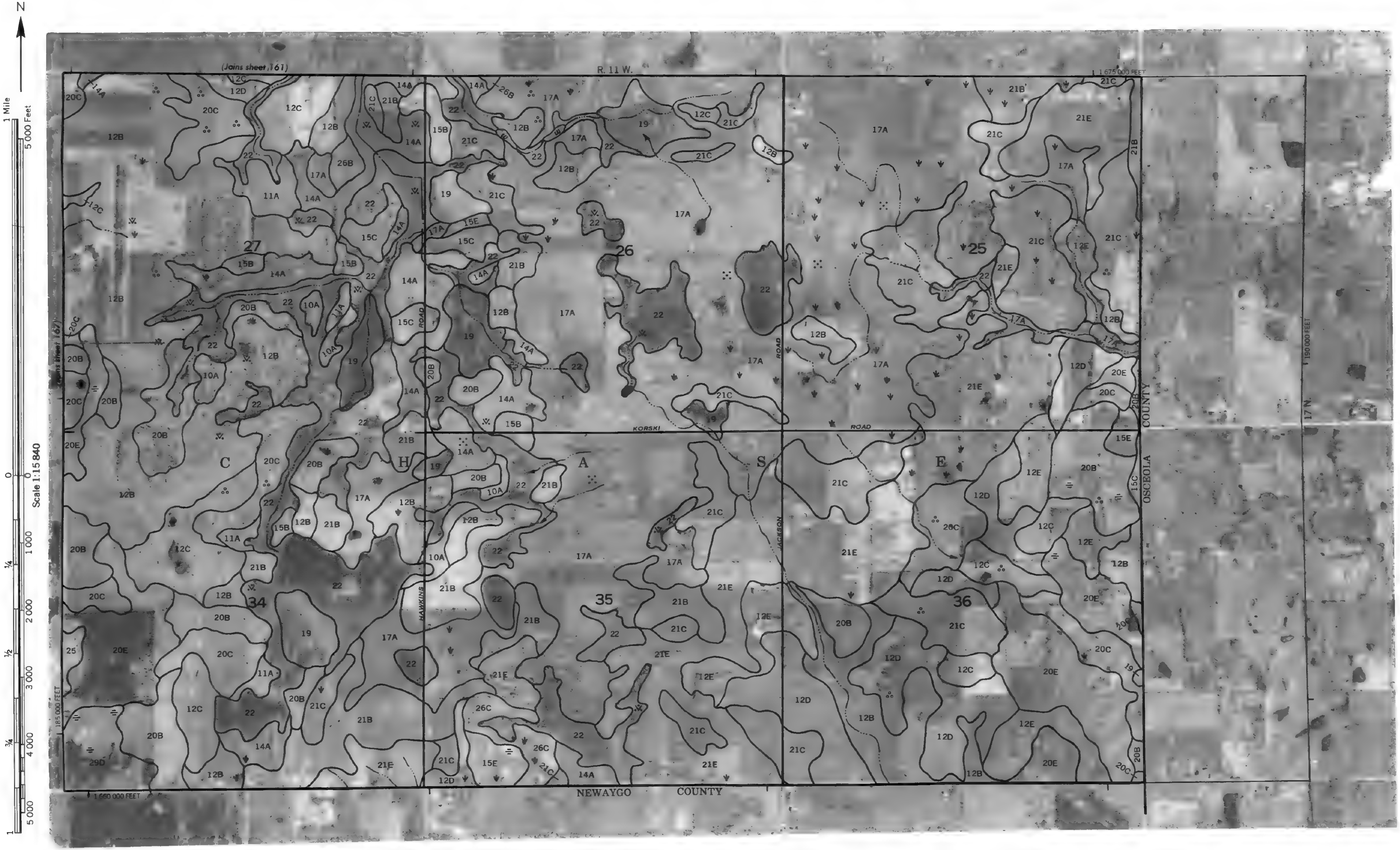
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 167

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

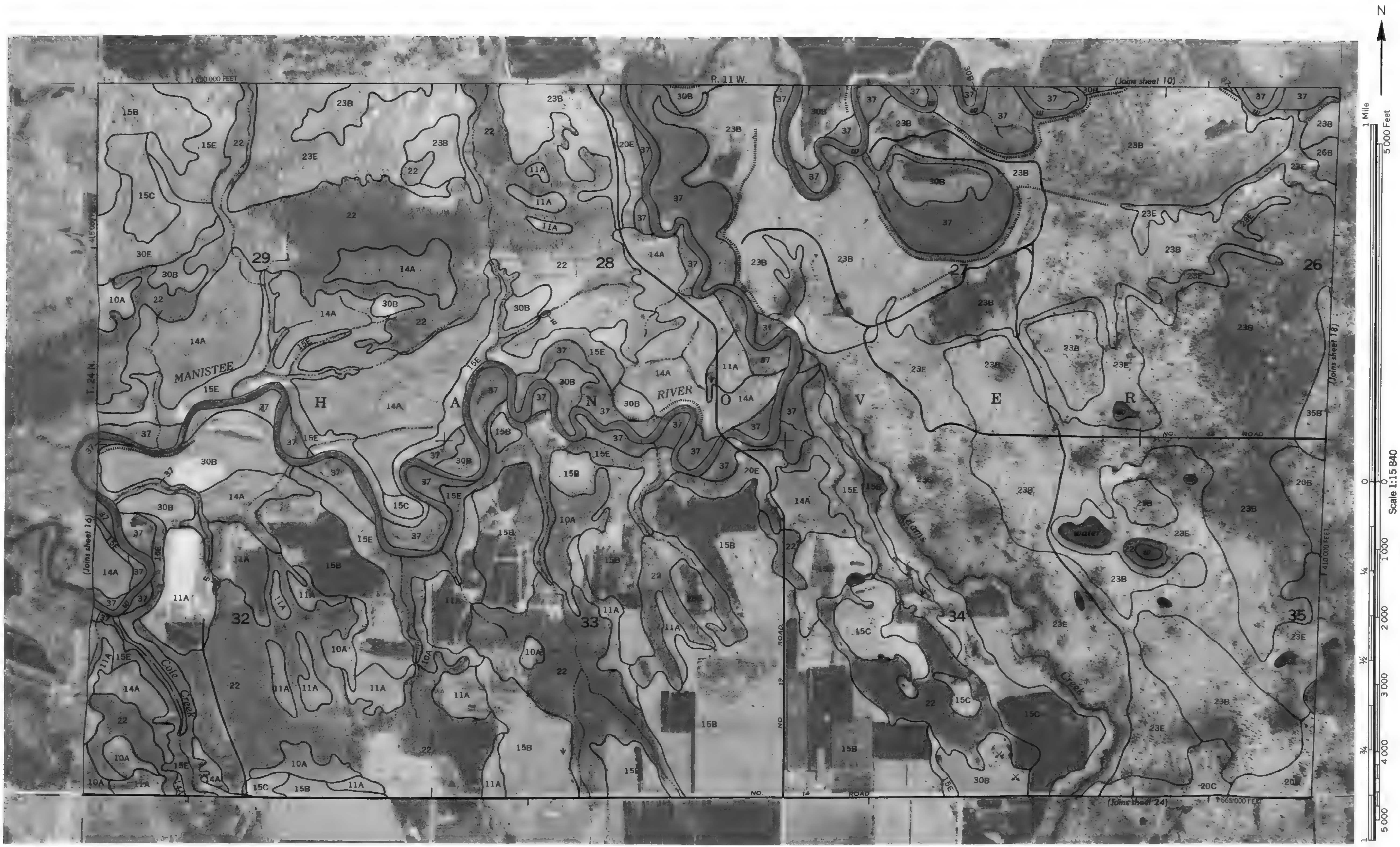
LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 168



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

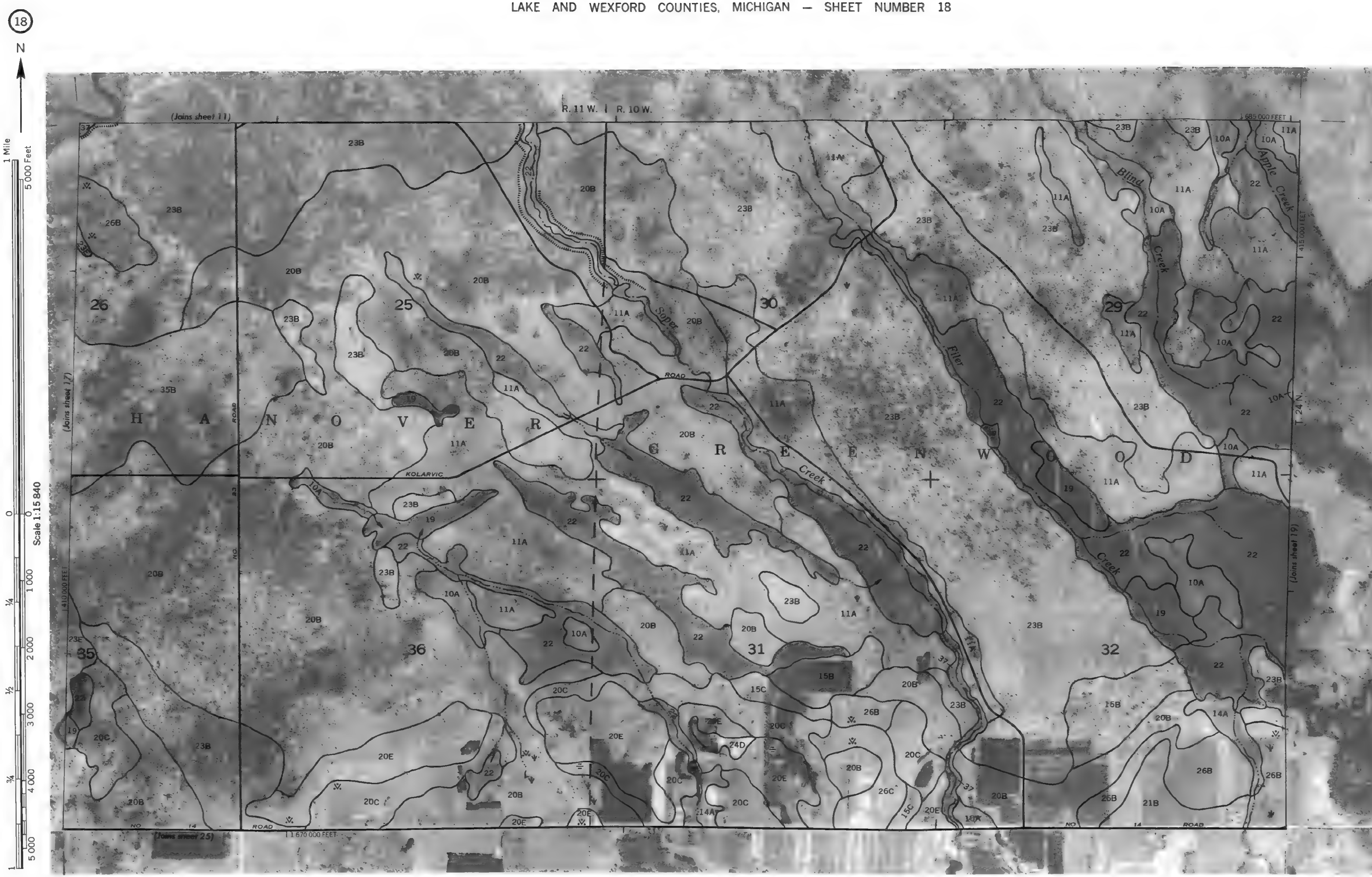
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 168

17



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 17

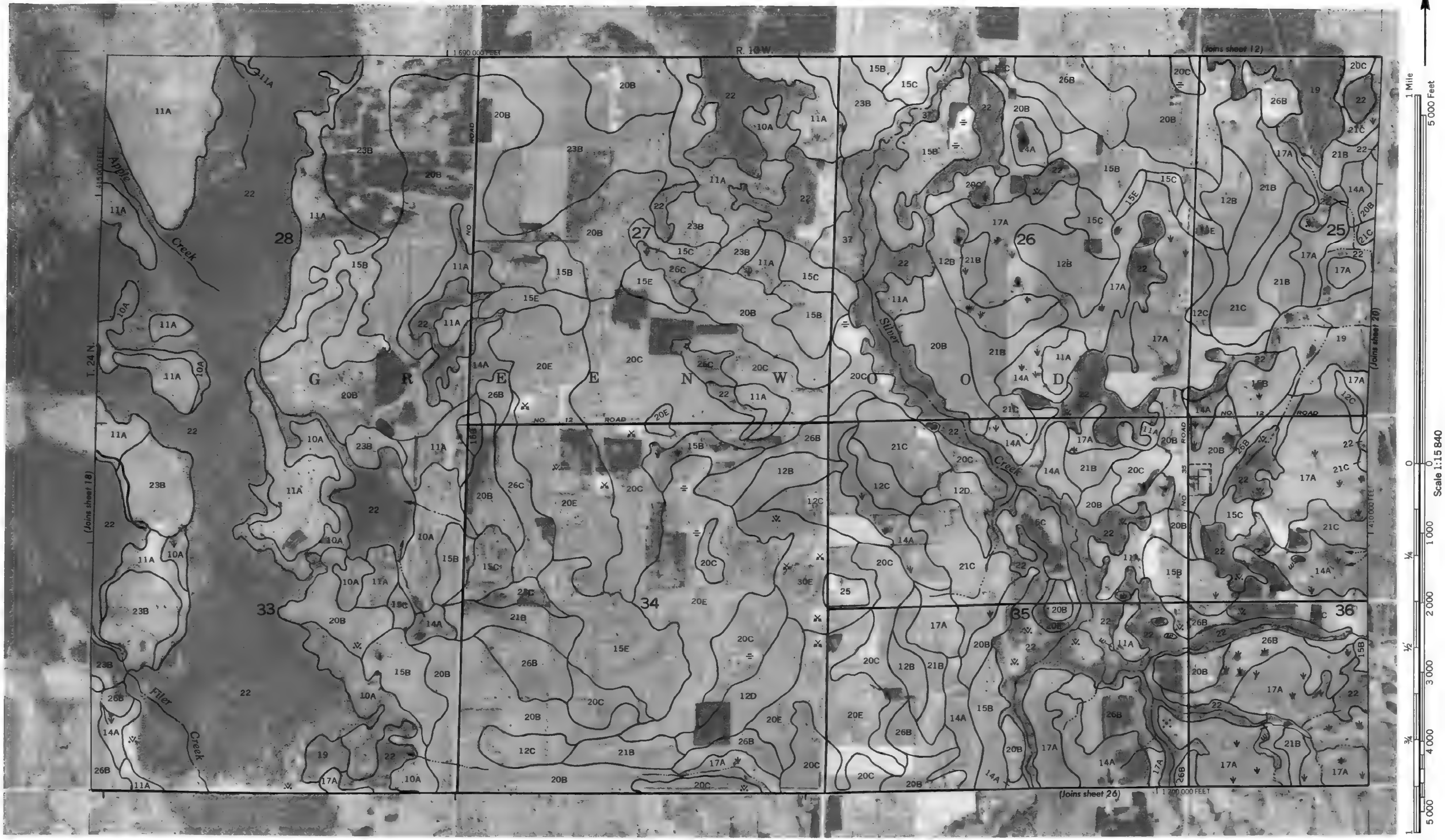
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 18

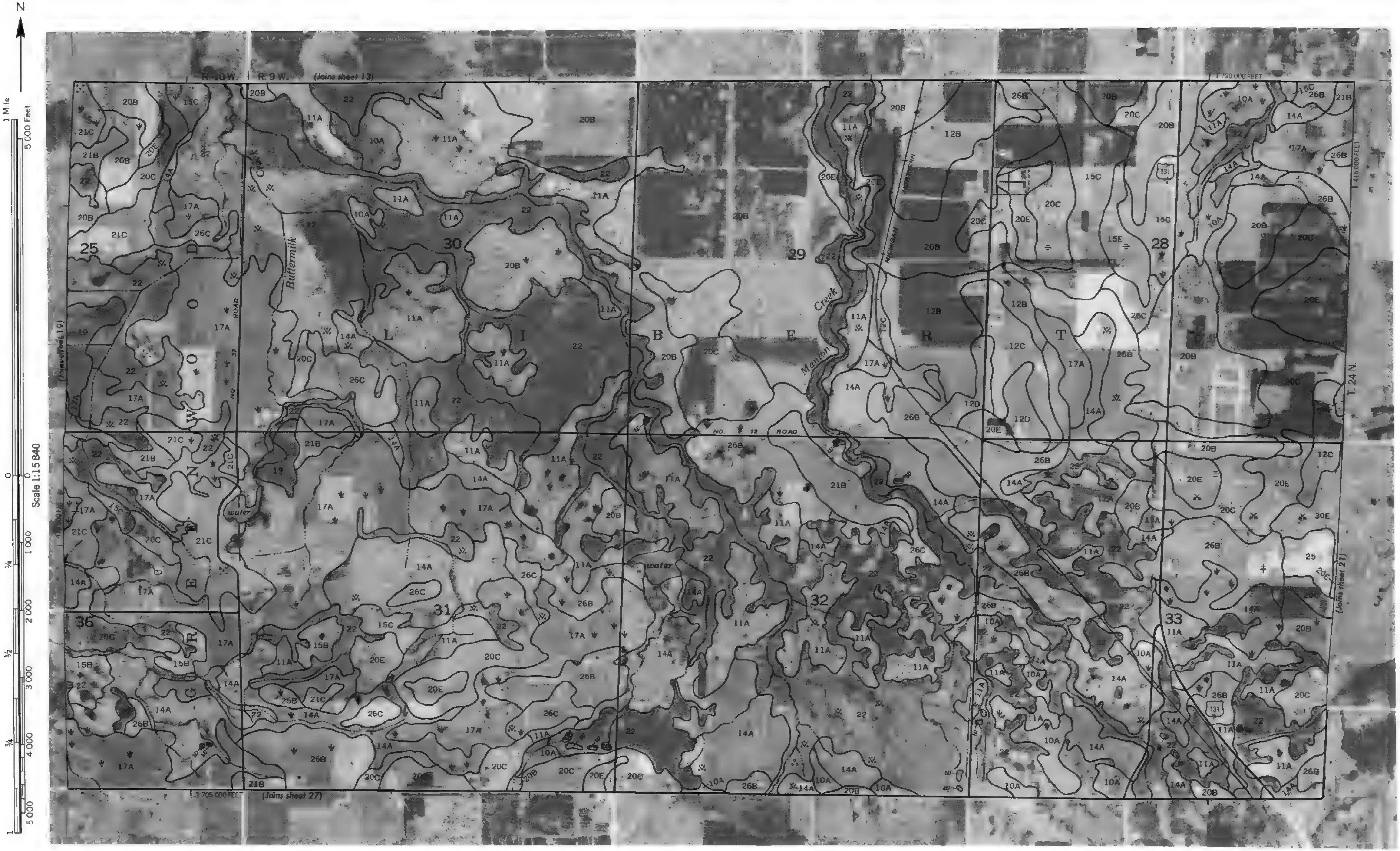
19



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 19

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

20



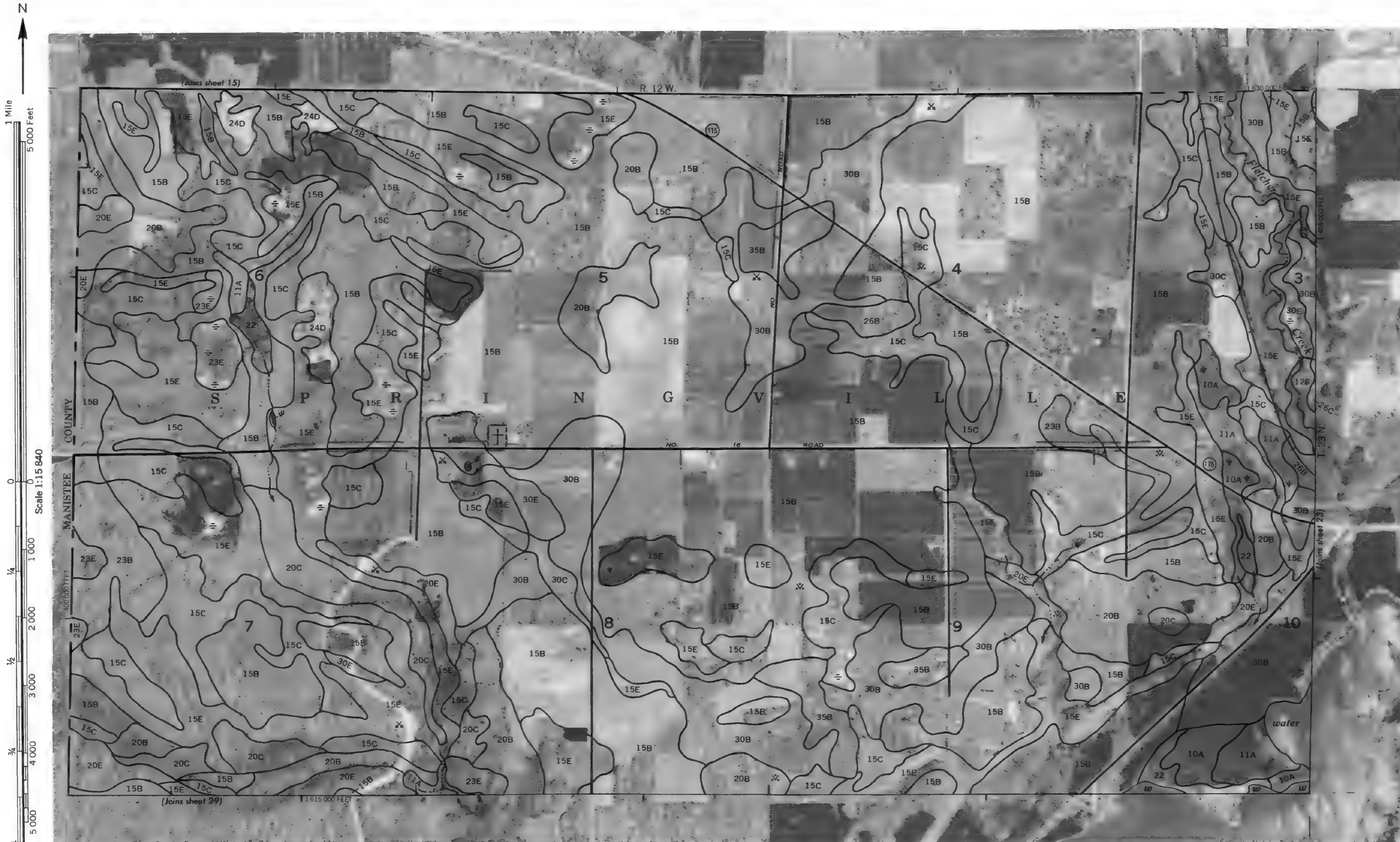
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 20

21

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 21

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



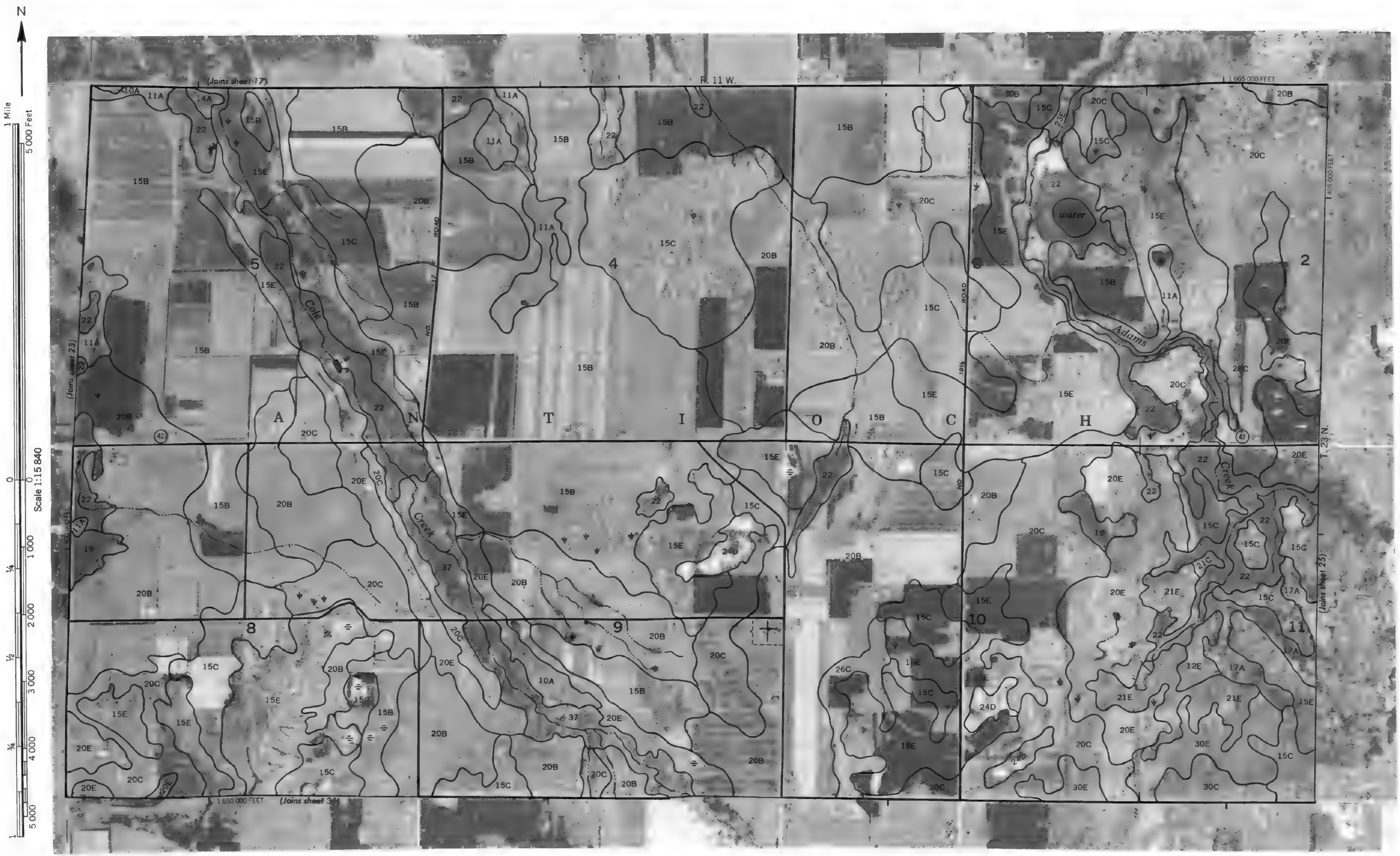
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 22

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 23

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

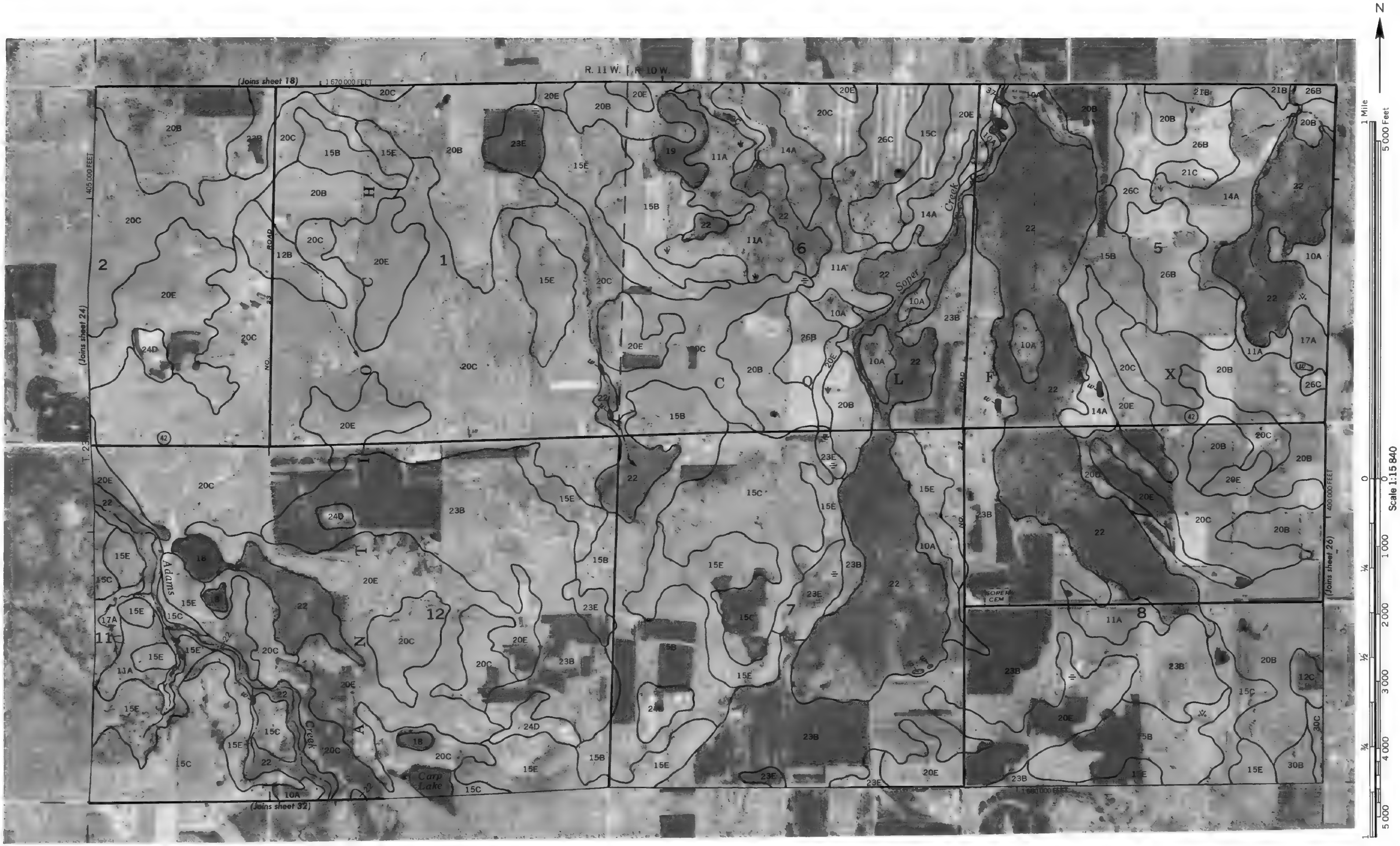
24



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 24

25



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 25

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 26

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 26

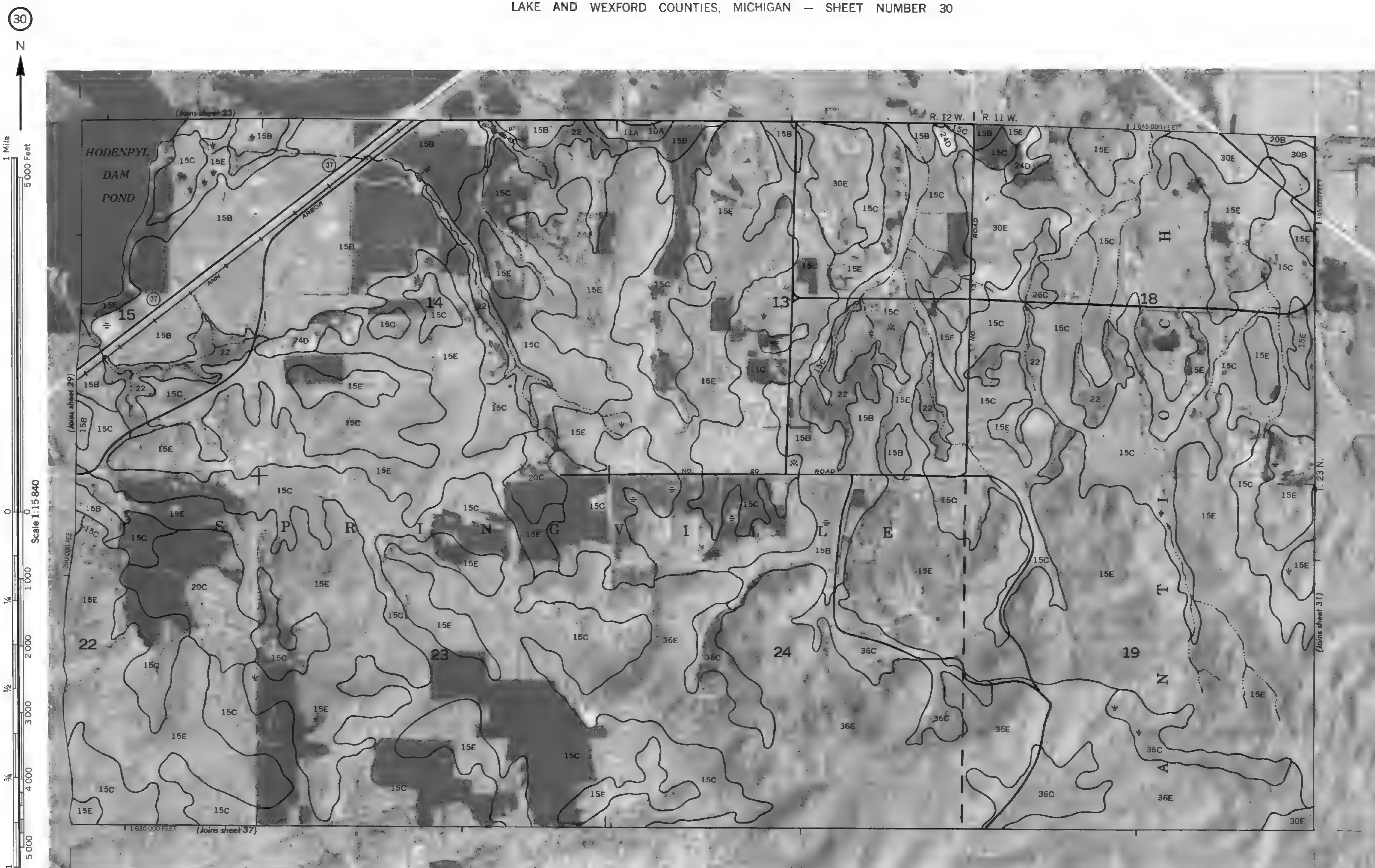
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 27

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

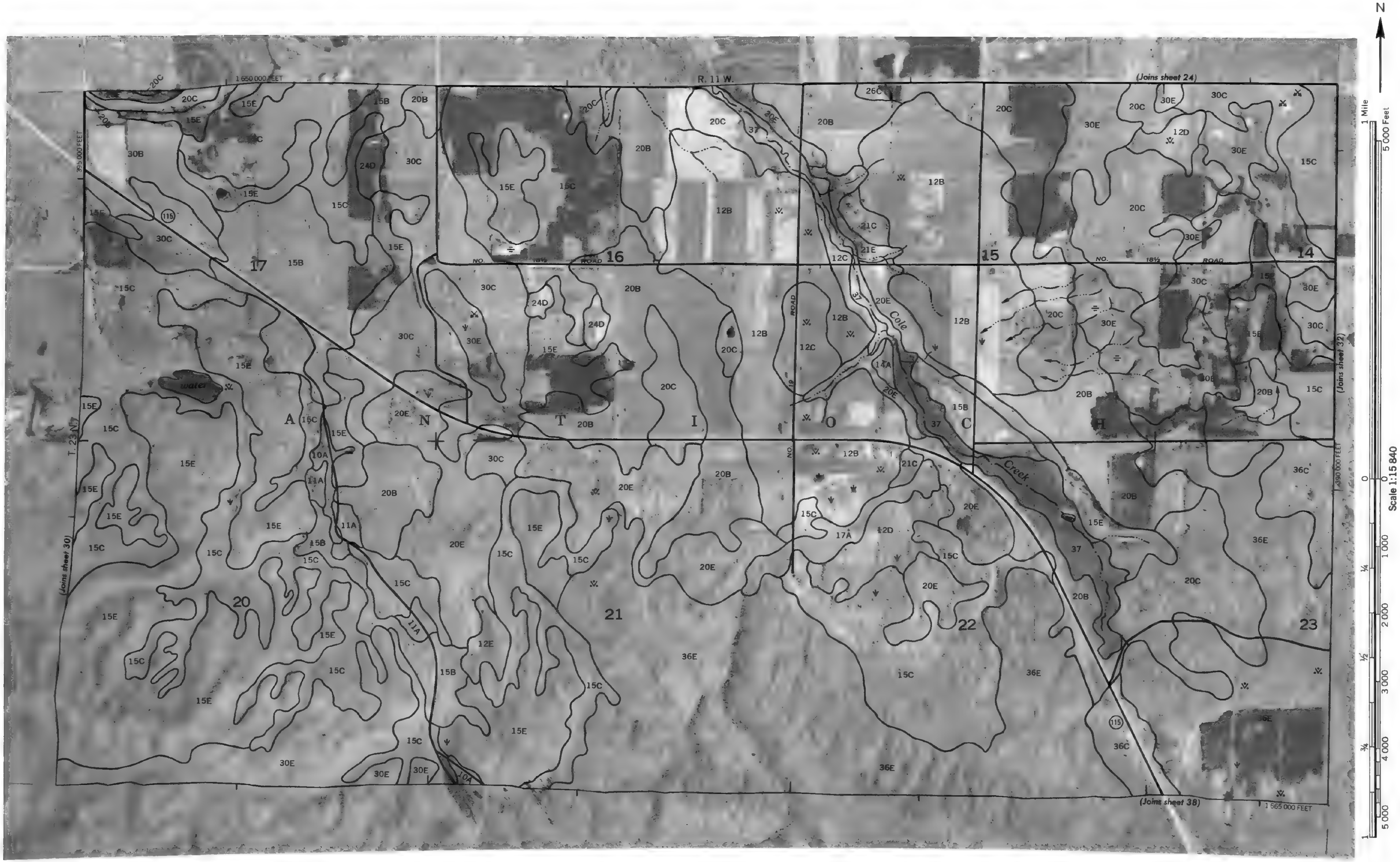

N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 21)
R. 9 W.
1 740 000 FEET
(Joins sheet 35)
1 725 000 FEET
(Joins sheet 27)
T. 23 N.
MISSAUKEE COUNTY
C E D A R C R E E K
MANTON
Billings Lake
Manton
Creek
ROAD
NO. 47 ROAD
1
2
3
10
11
12
131
42

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 29

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

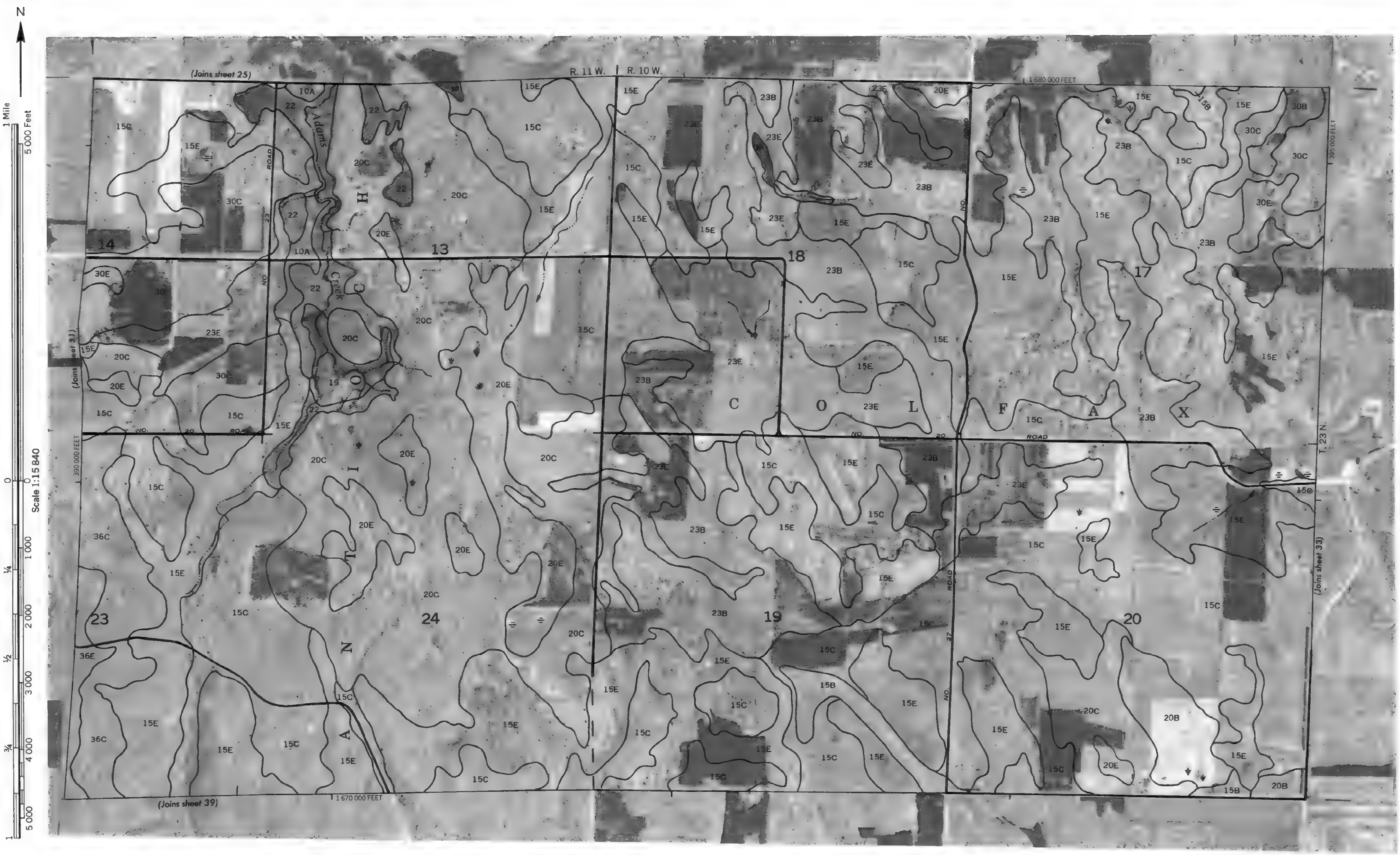


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 31

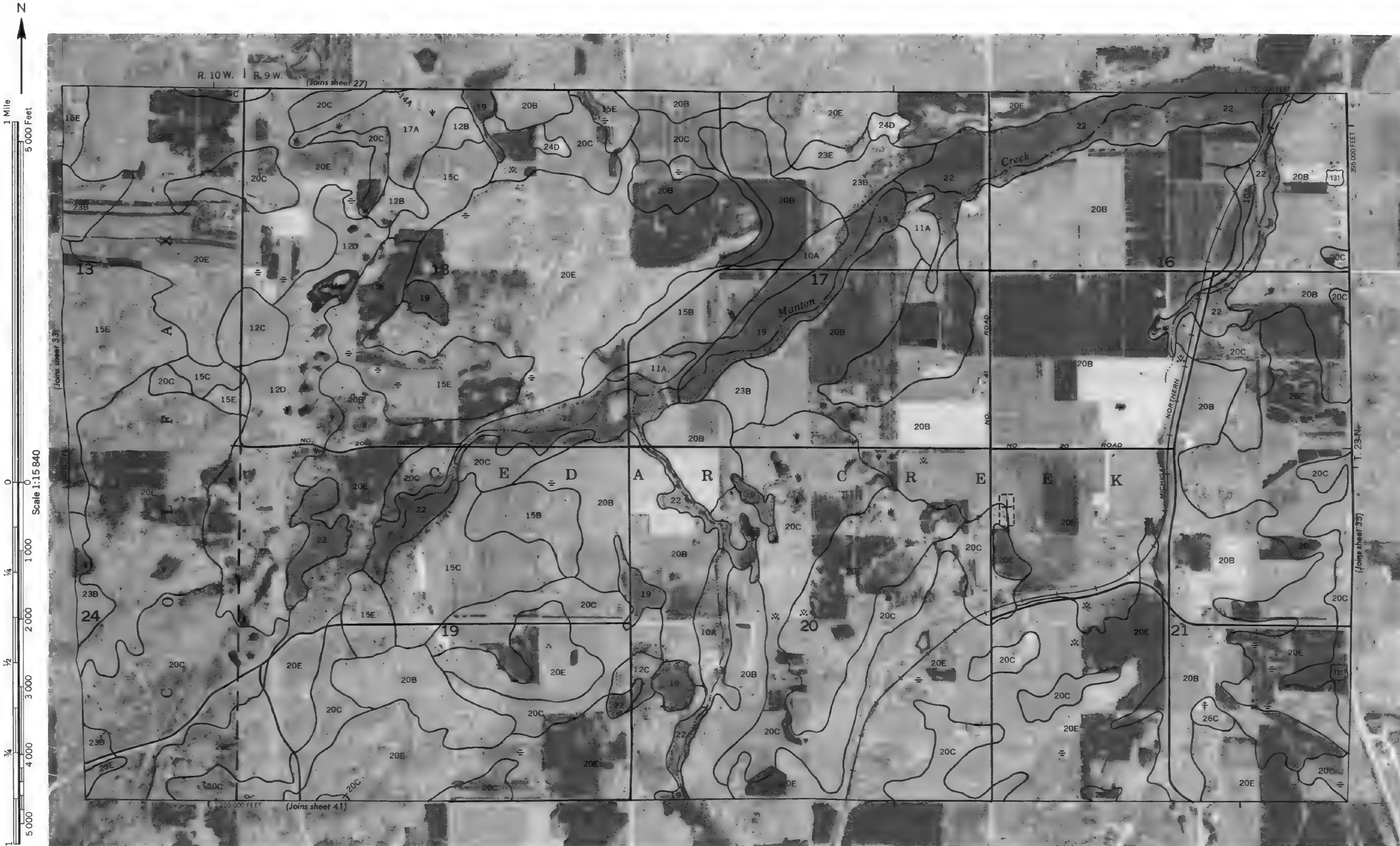
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



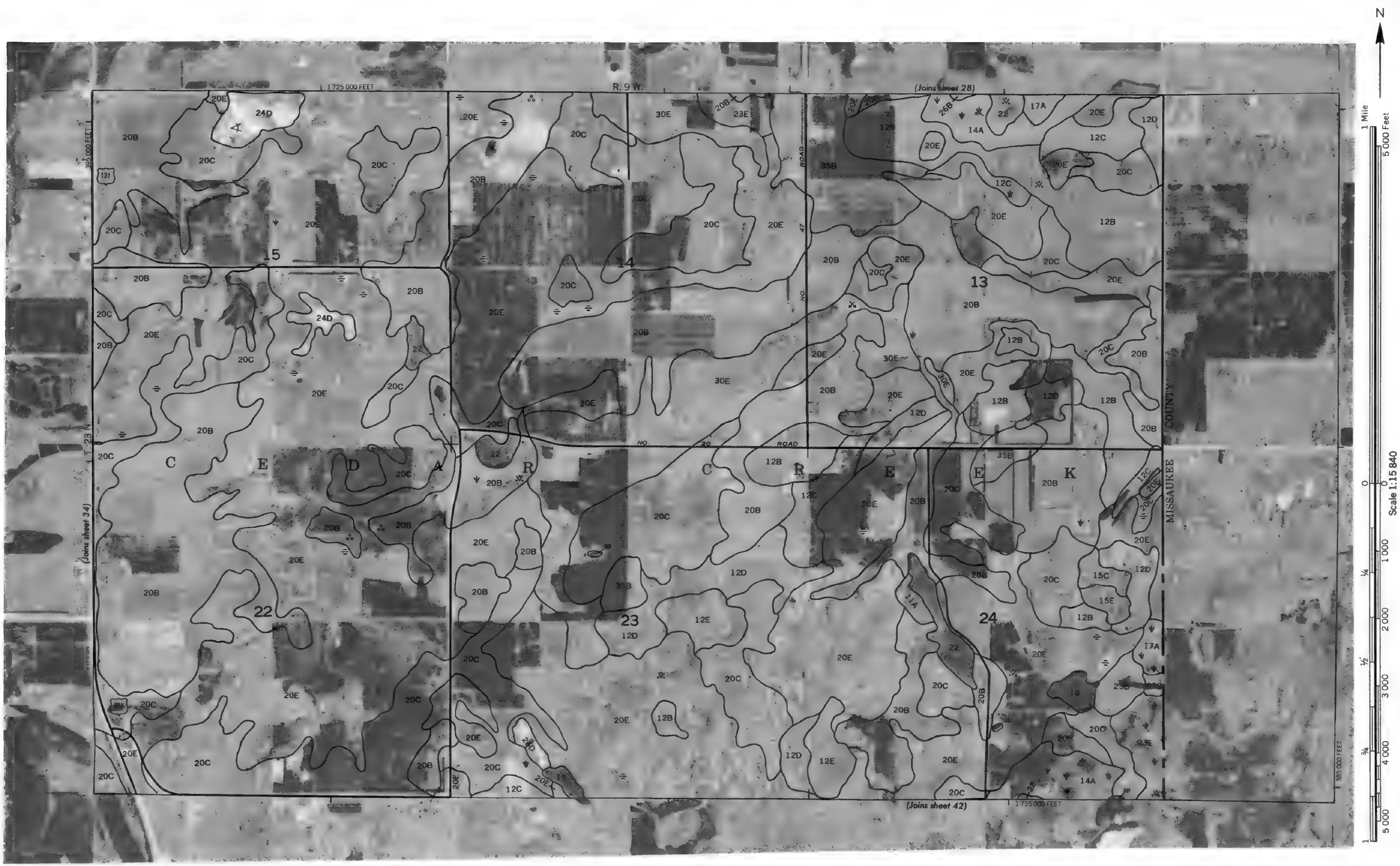
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 33

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 35

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

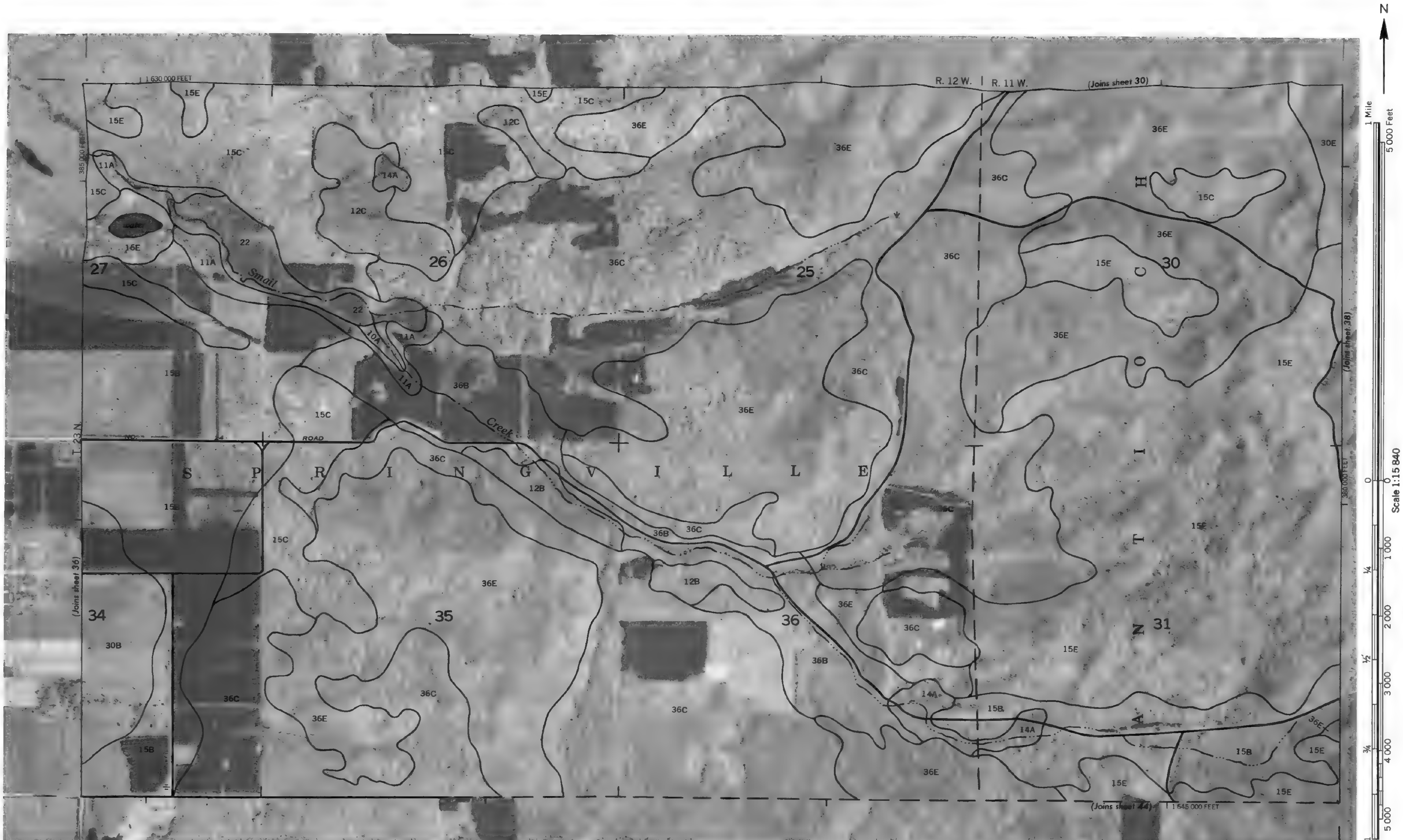
LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 36

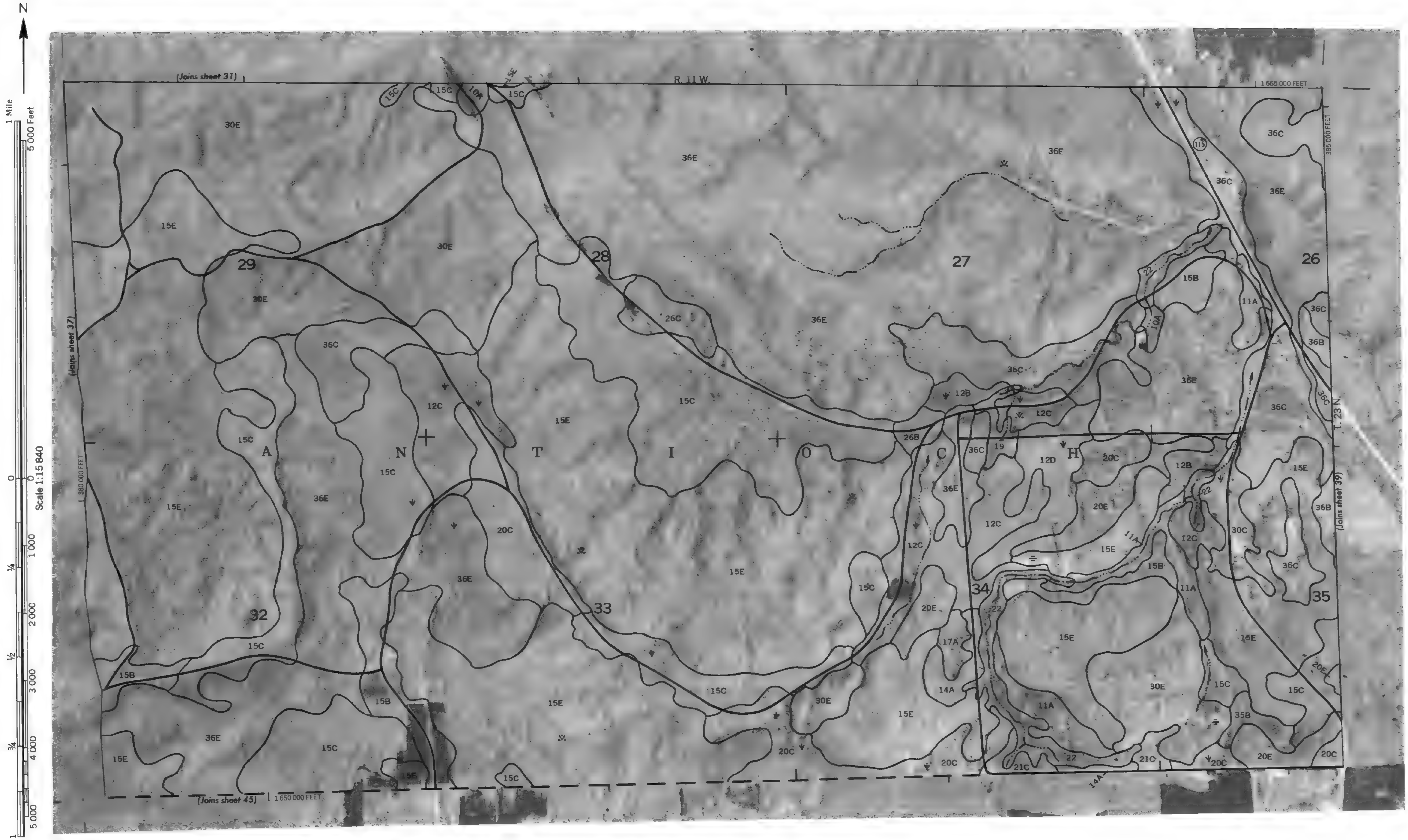
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 36

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 37

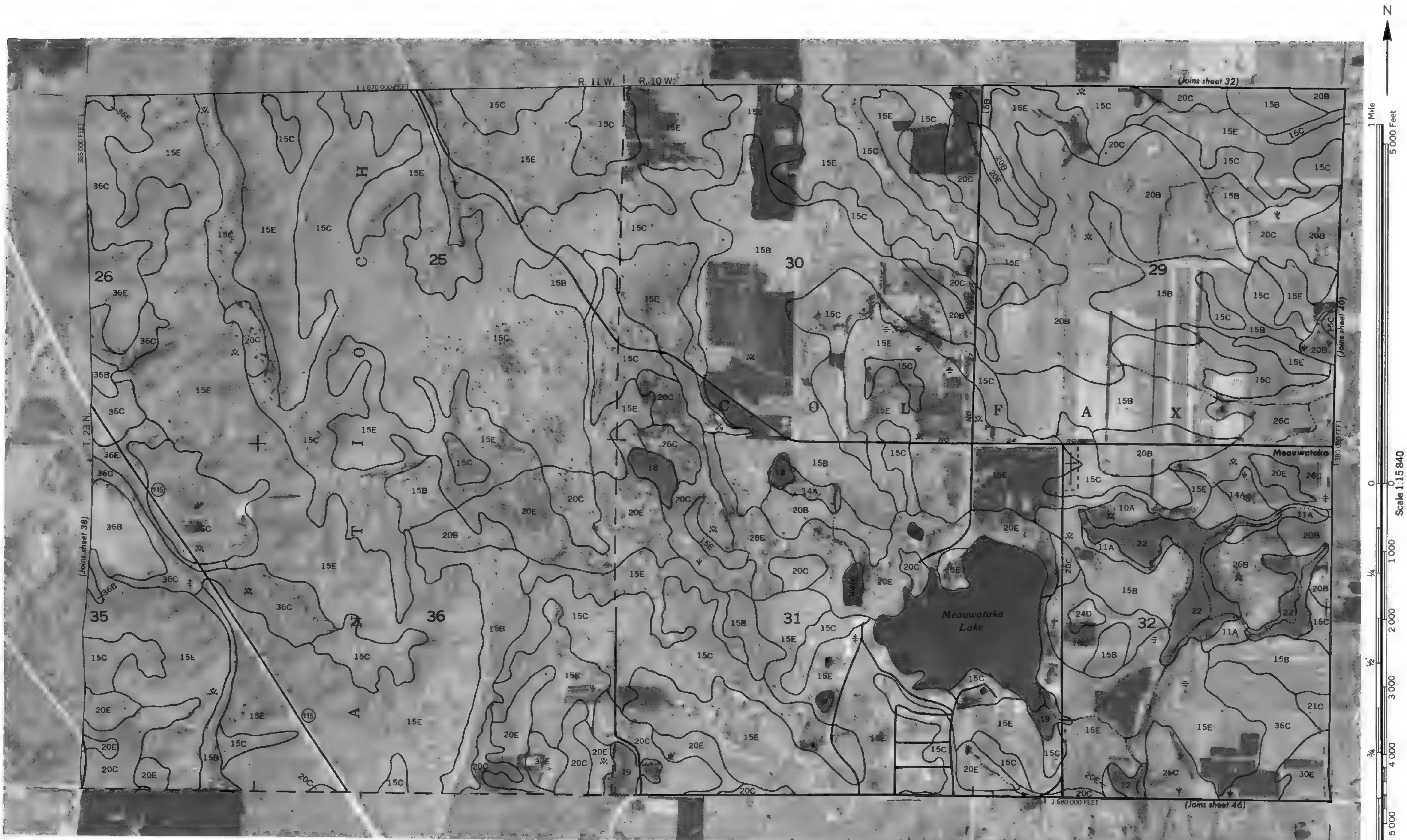
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





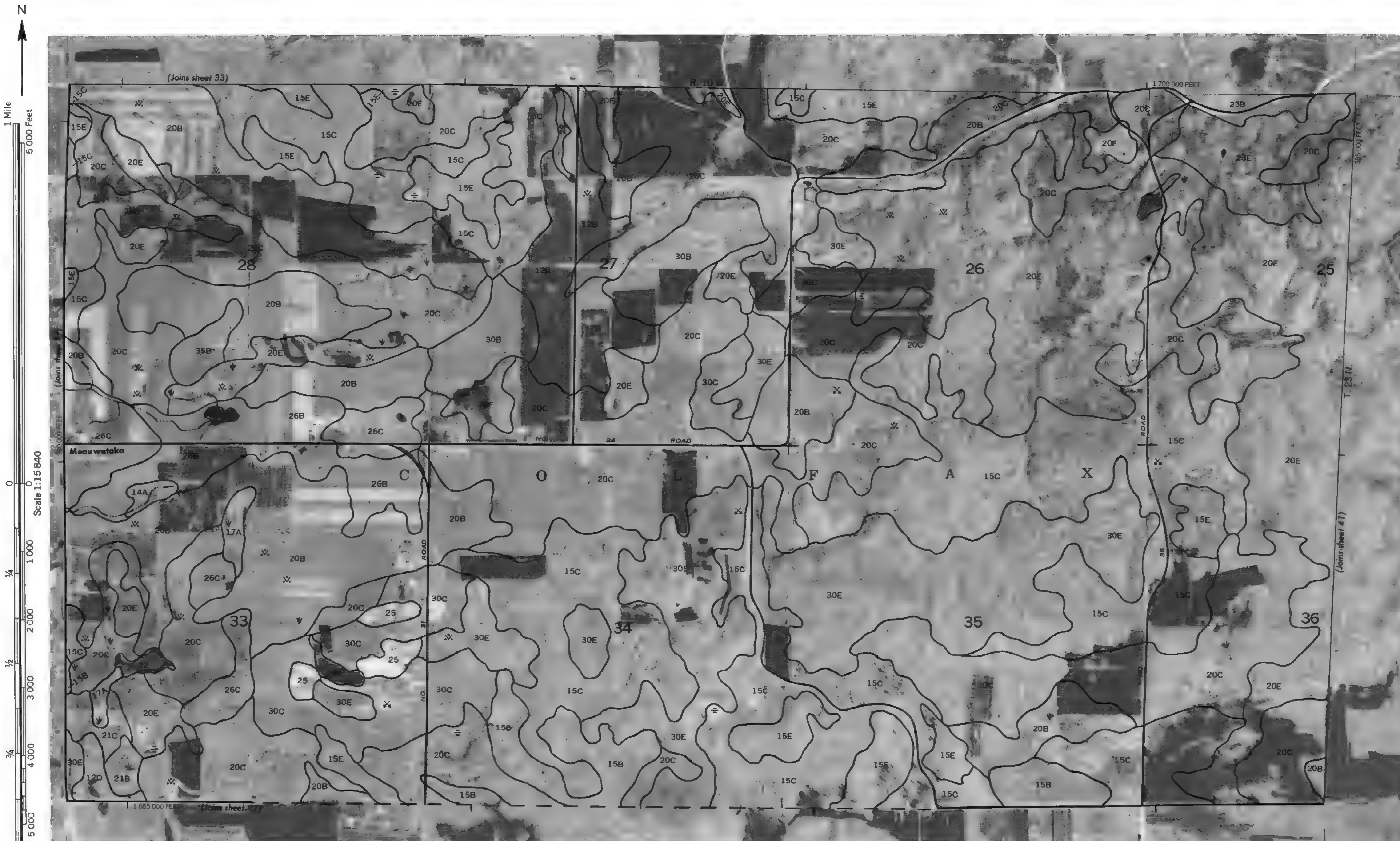
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 38



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 39

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

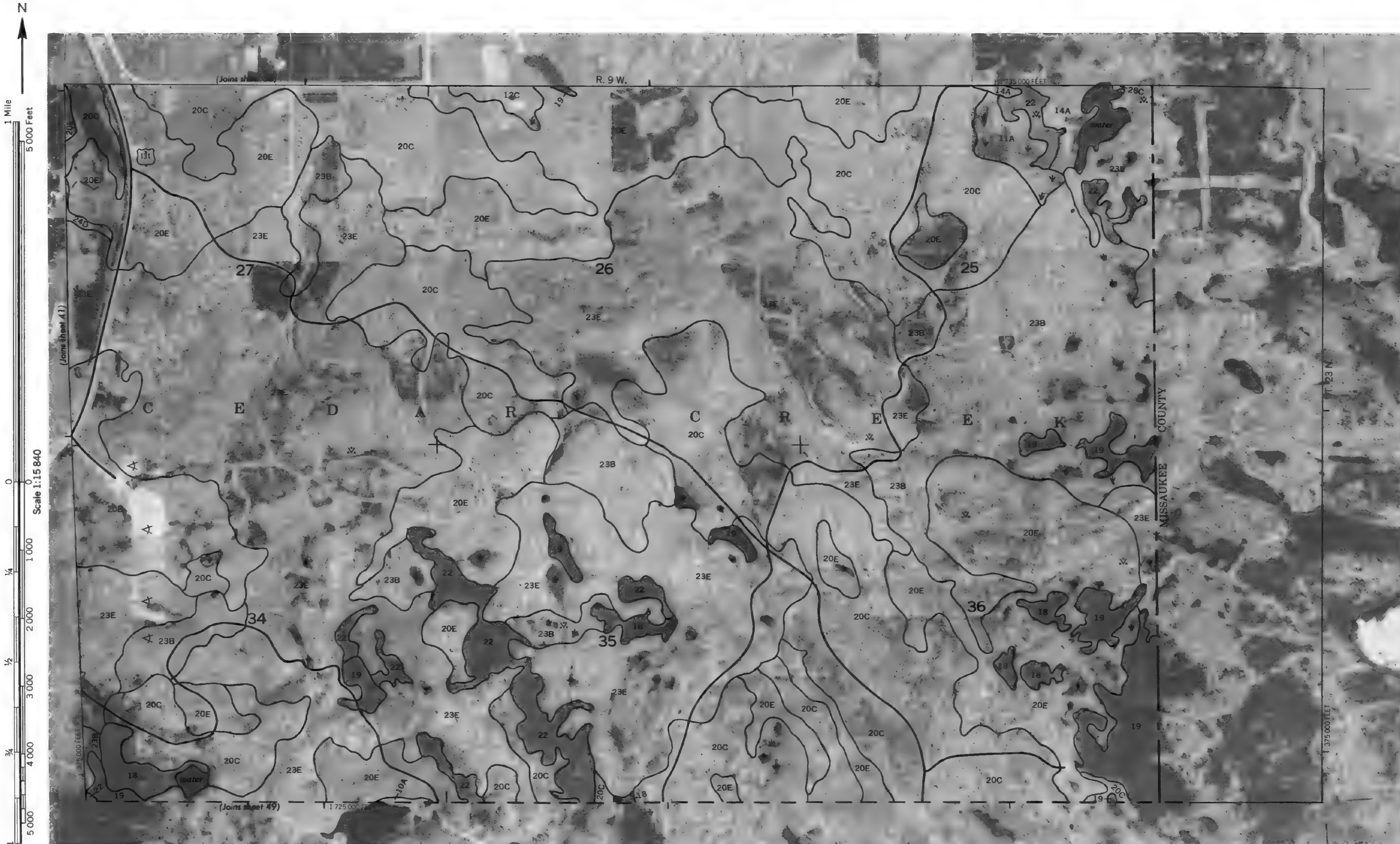


This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

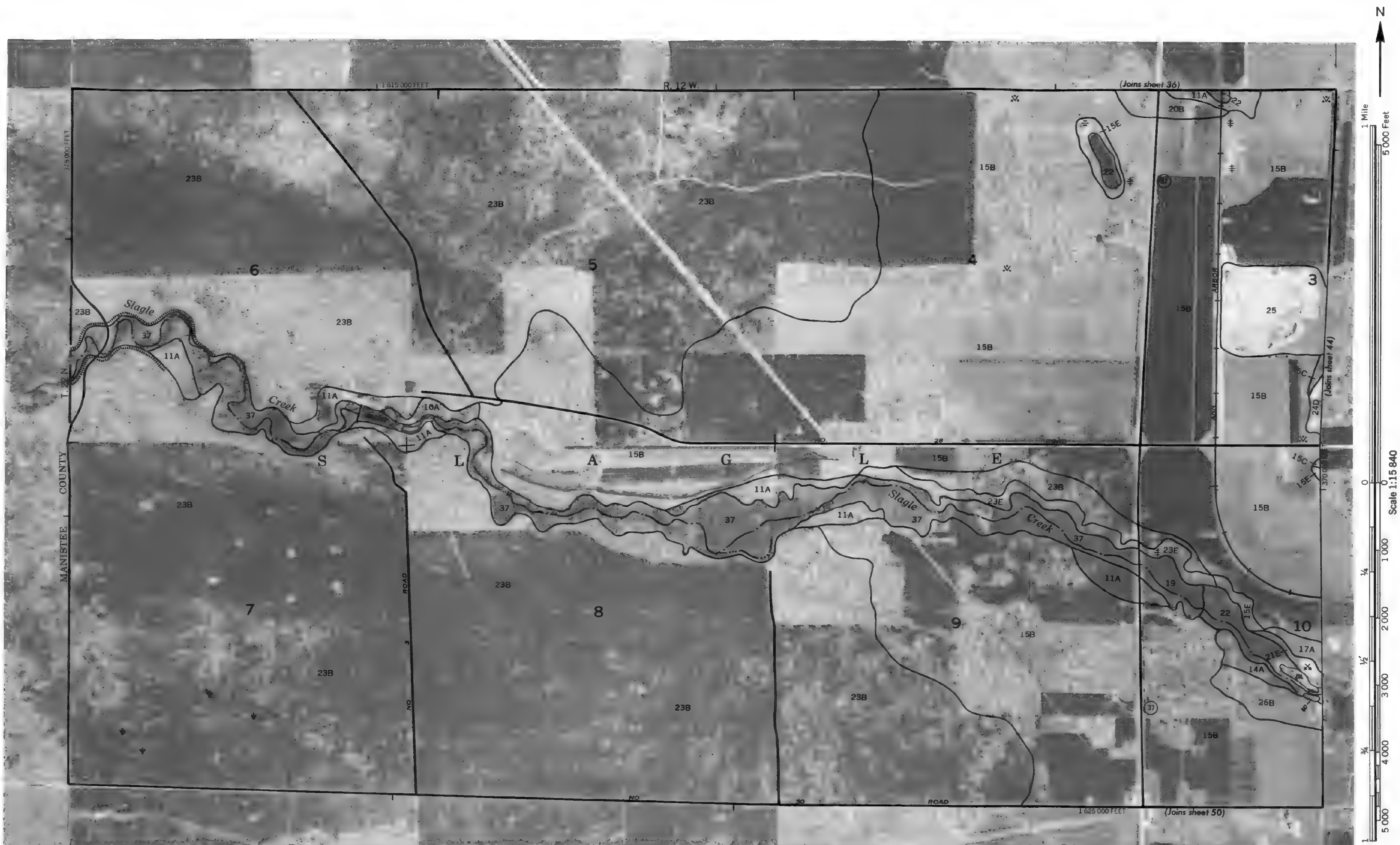
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 40

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 41

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 43

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 44

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 44

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 45

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


46
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 39)
(Joins sheet 53)
(Joins sheet 47)
(Joins sheet 45)
R. 11 W.
R. 10 W.
1 680 000 FEET
1 670 000 FEET
375 000 FEET
Woodward Lake
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 46
This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 47

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

48

N

1 Mile

5 000 Feet

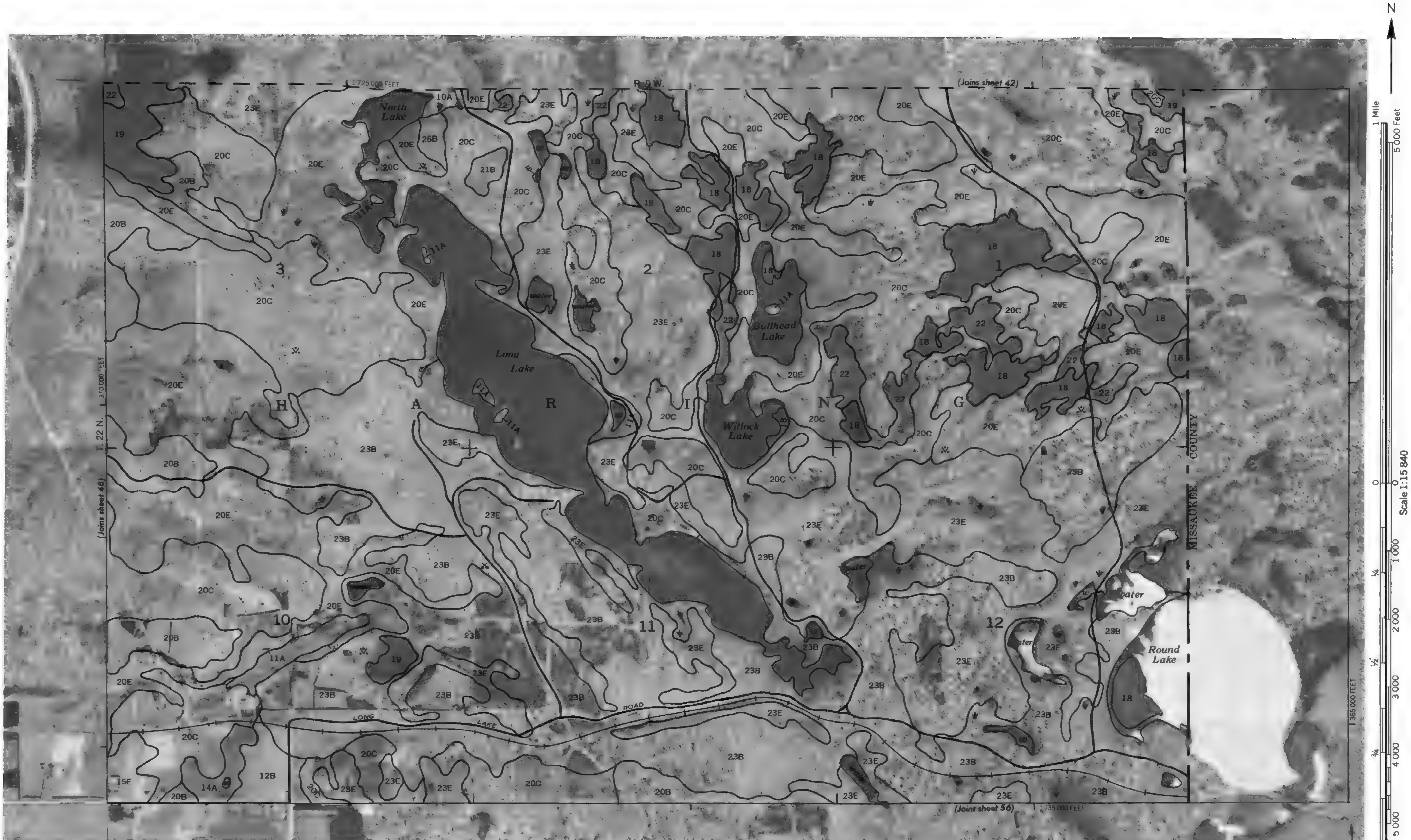
Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

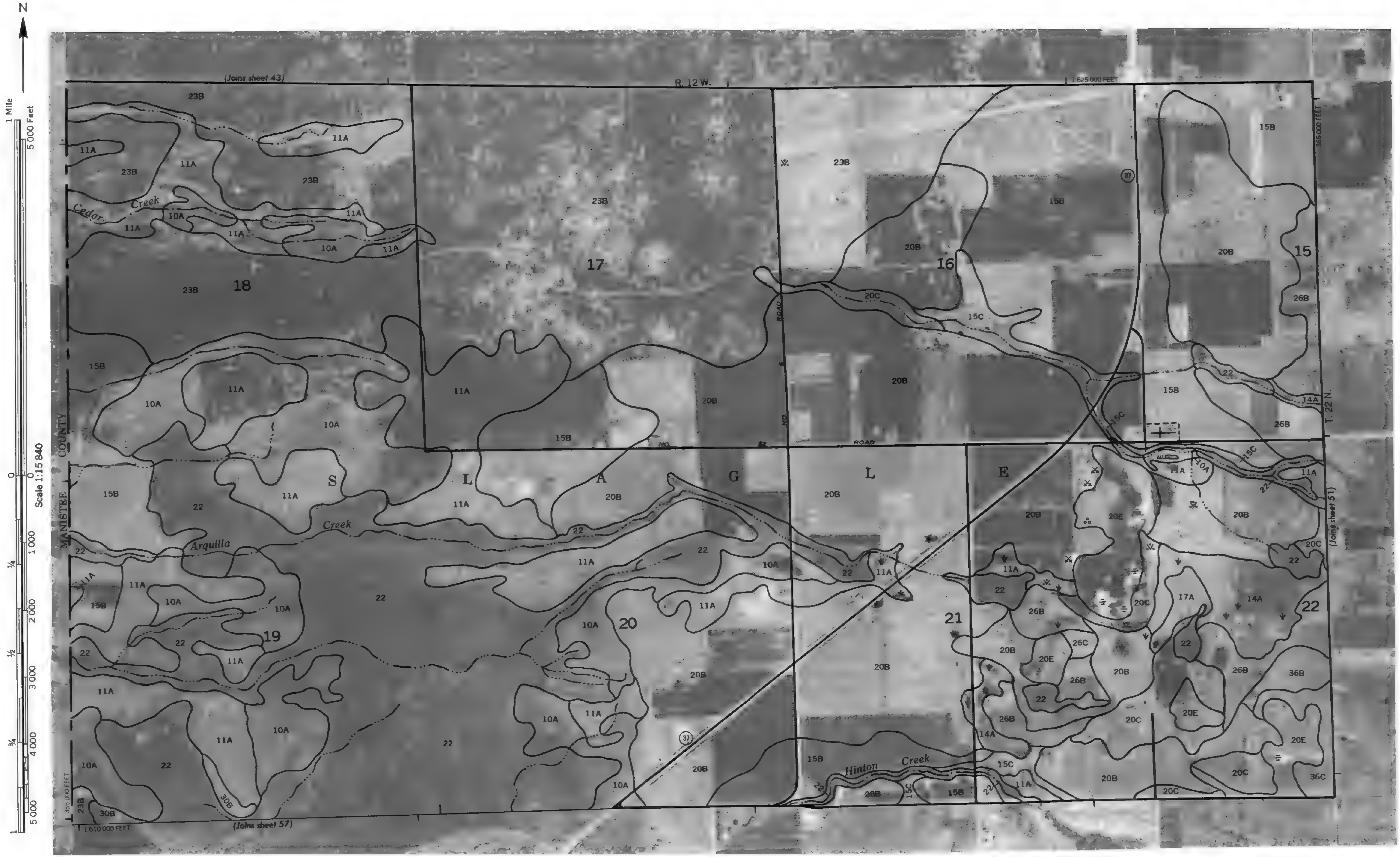
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

49



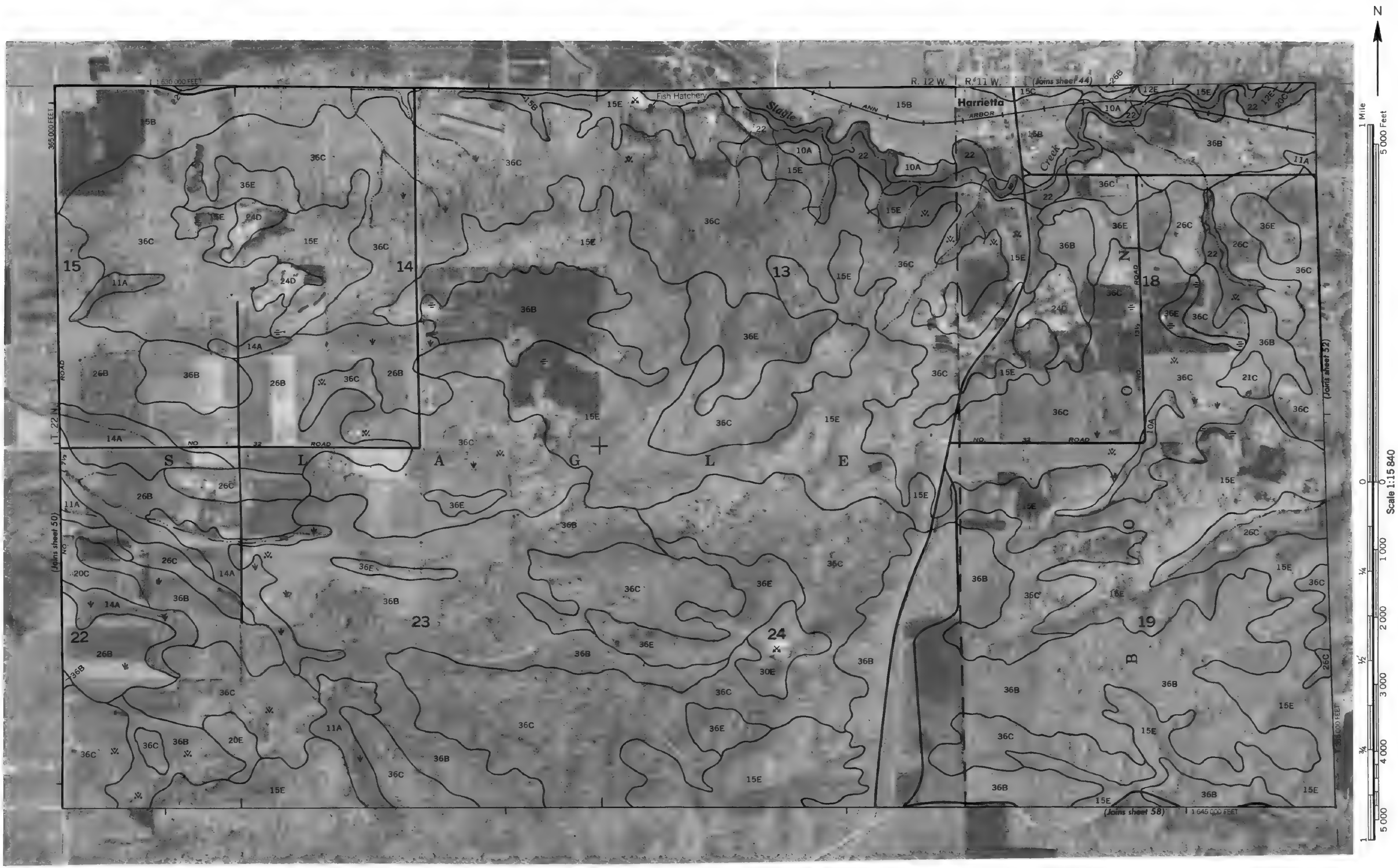
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 49

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

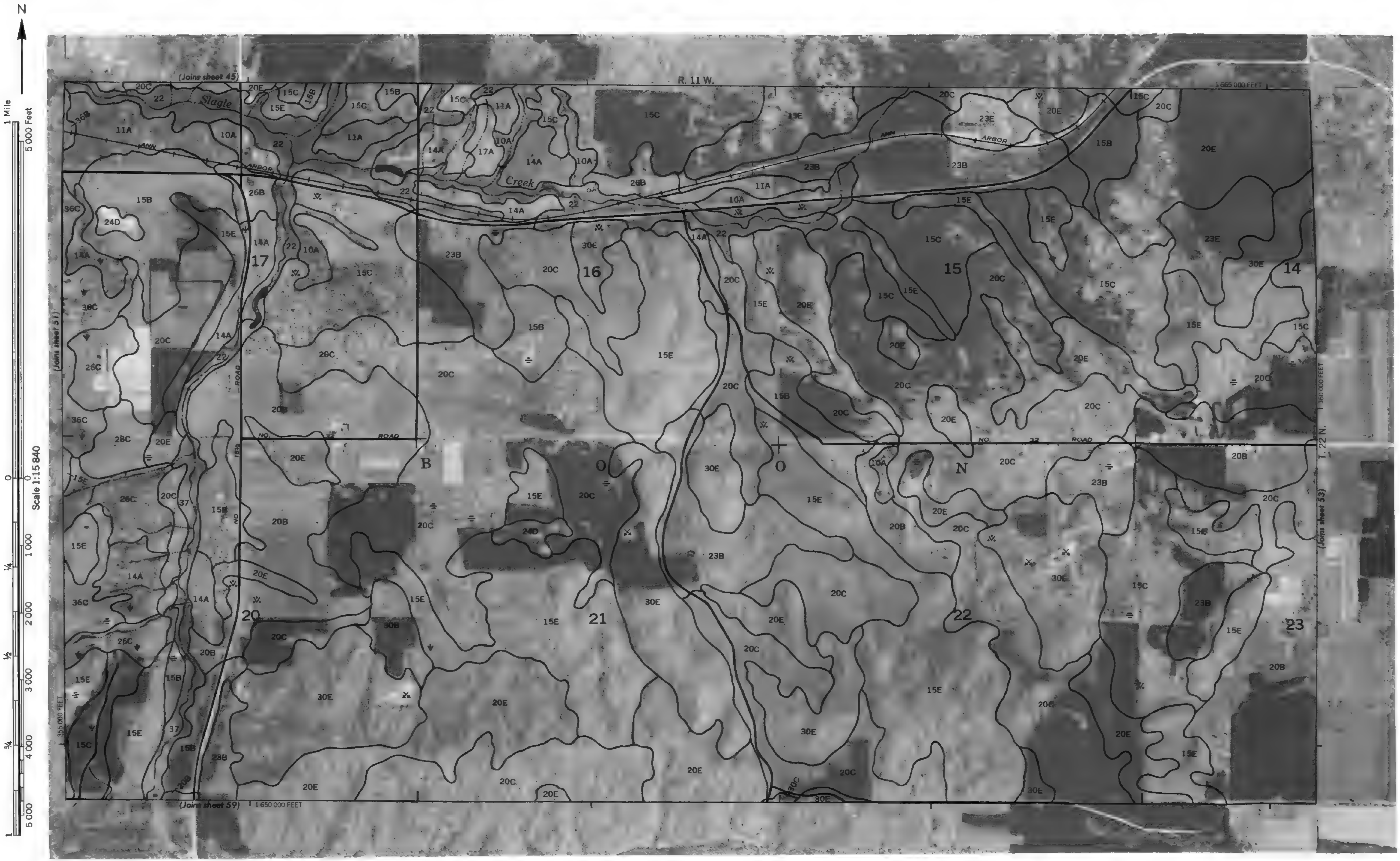


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 50



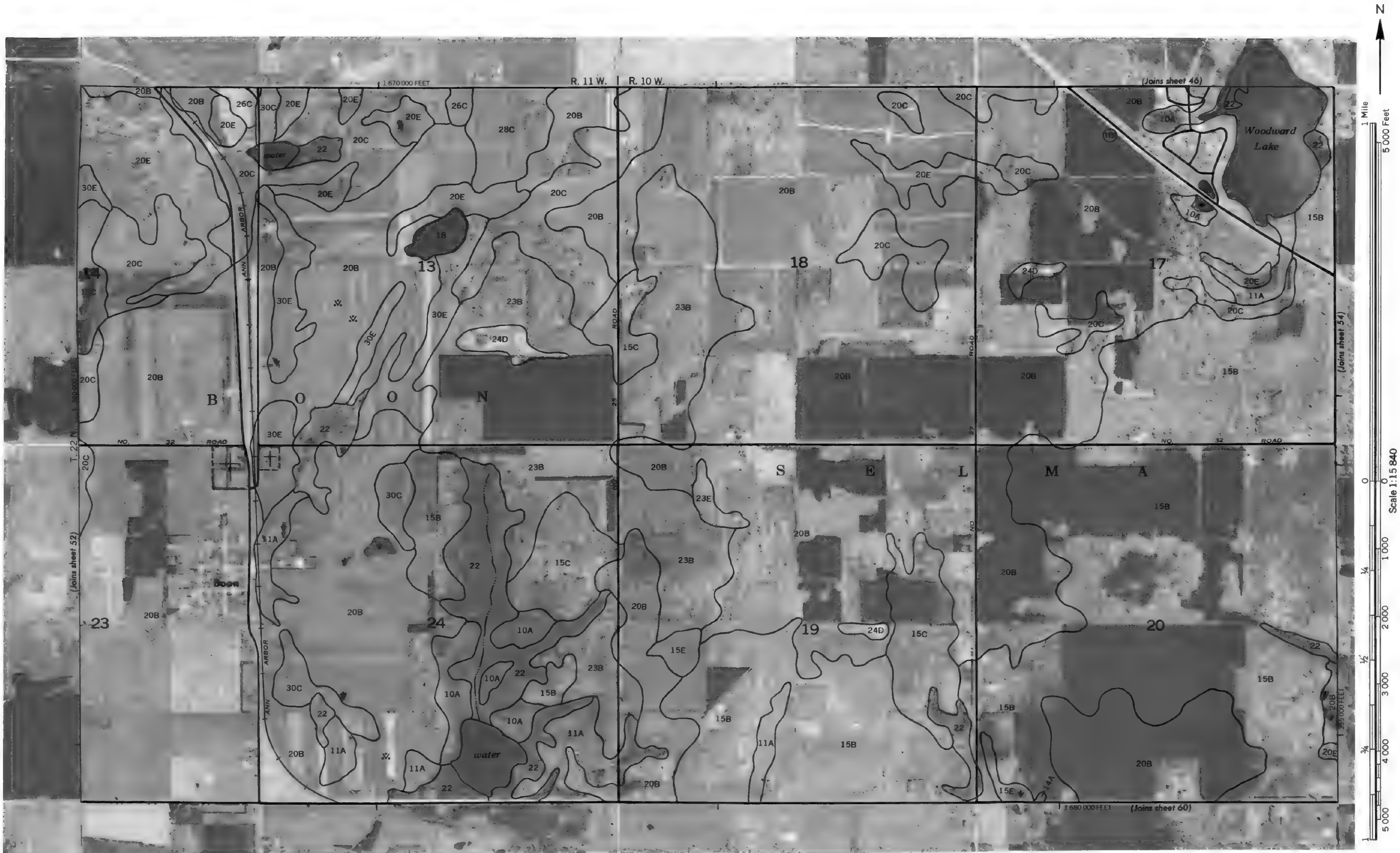
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

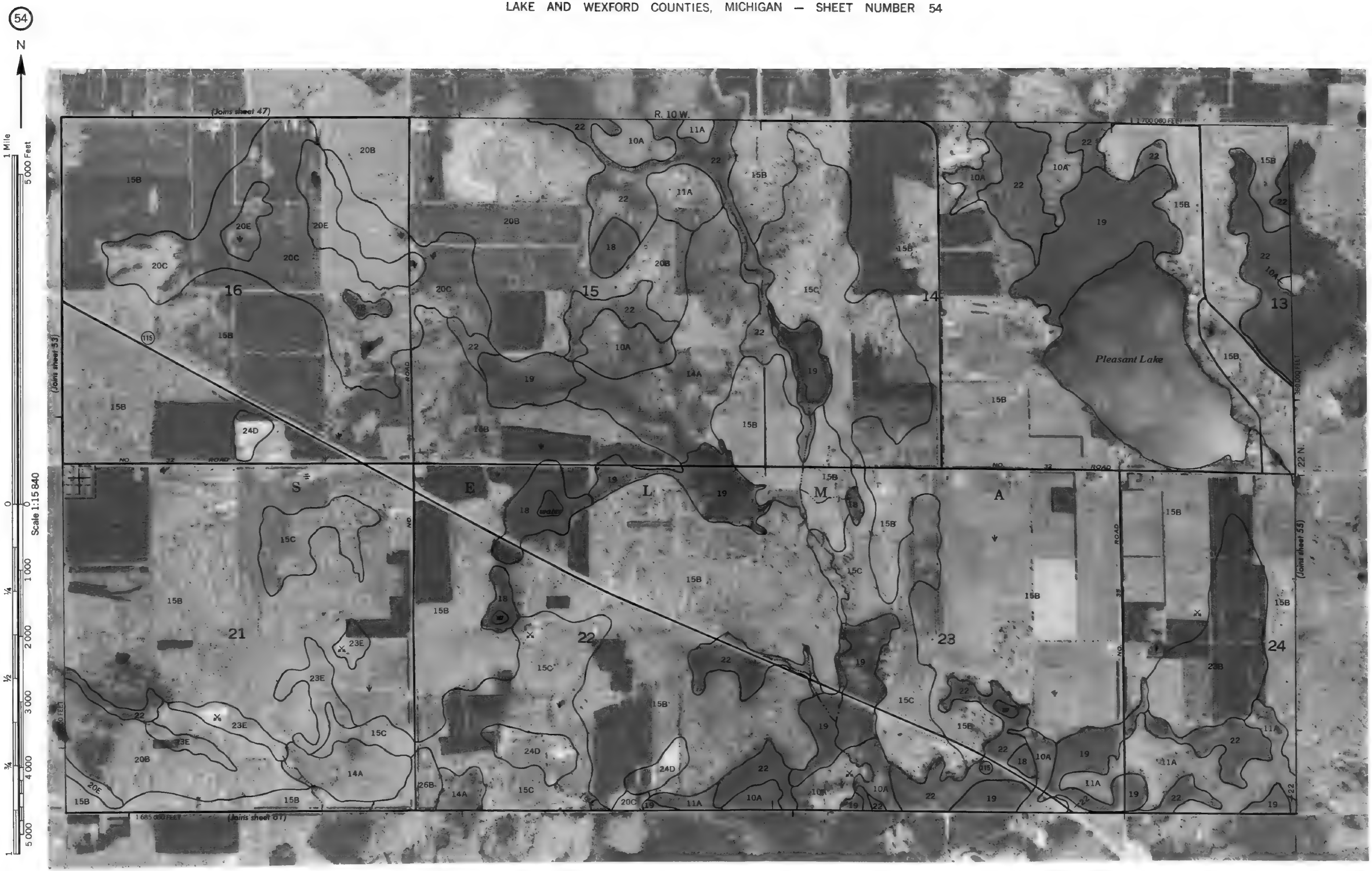


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 53

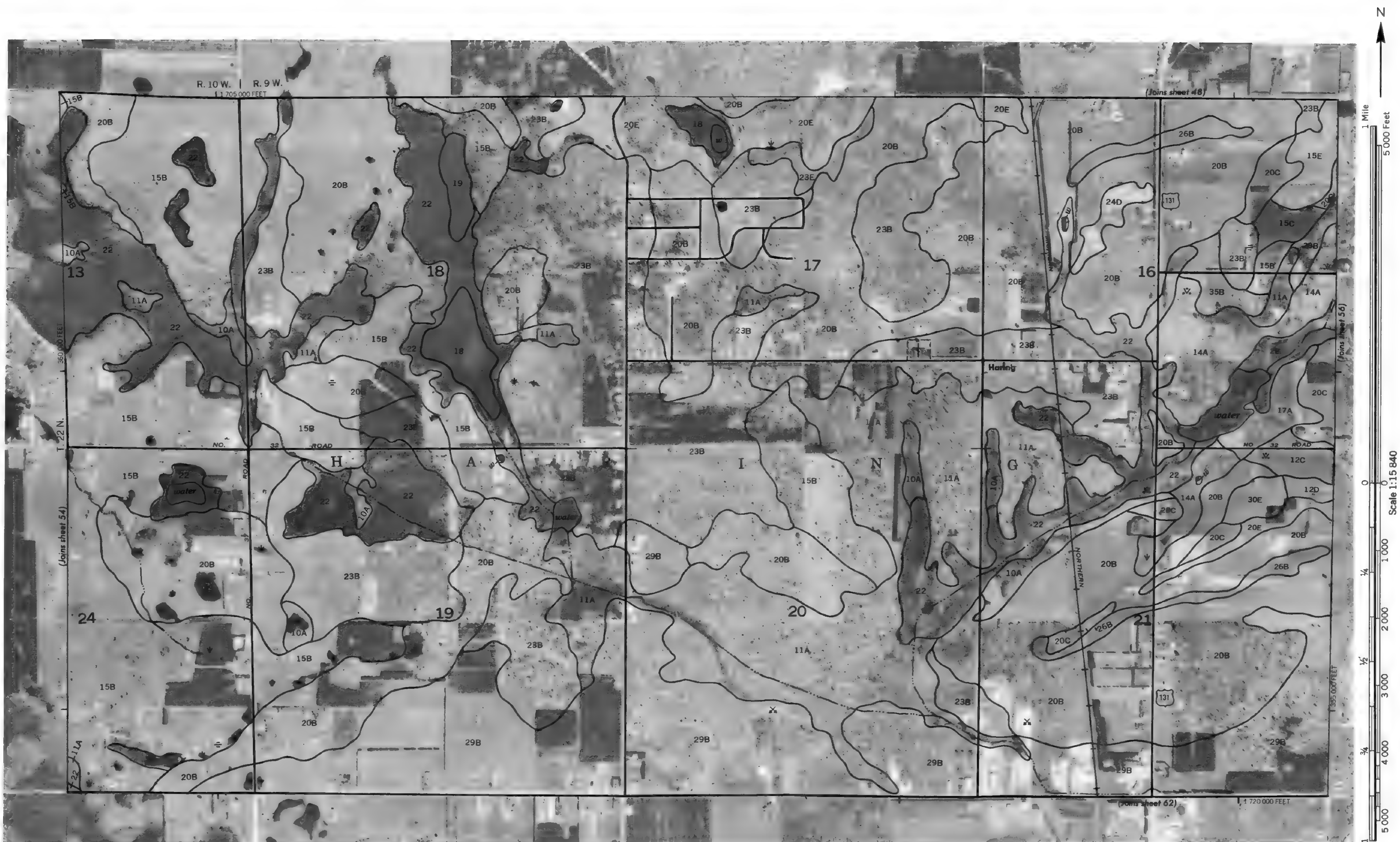
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 54



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 55

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 56

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 56

N

Scale 1:15 840

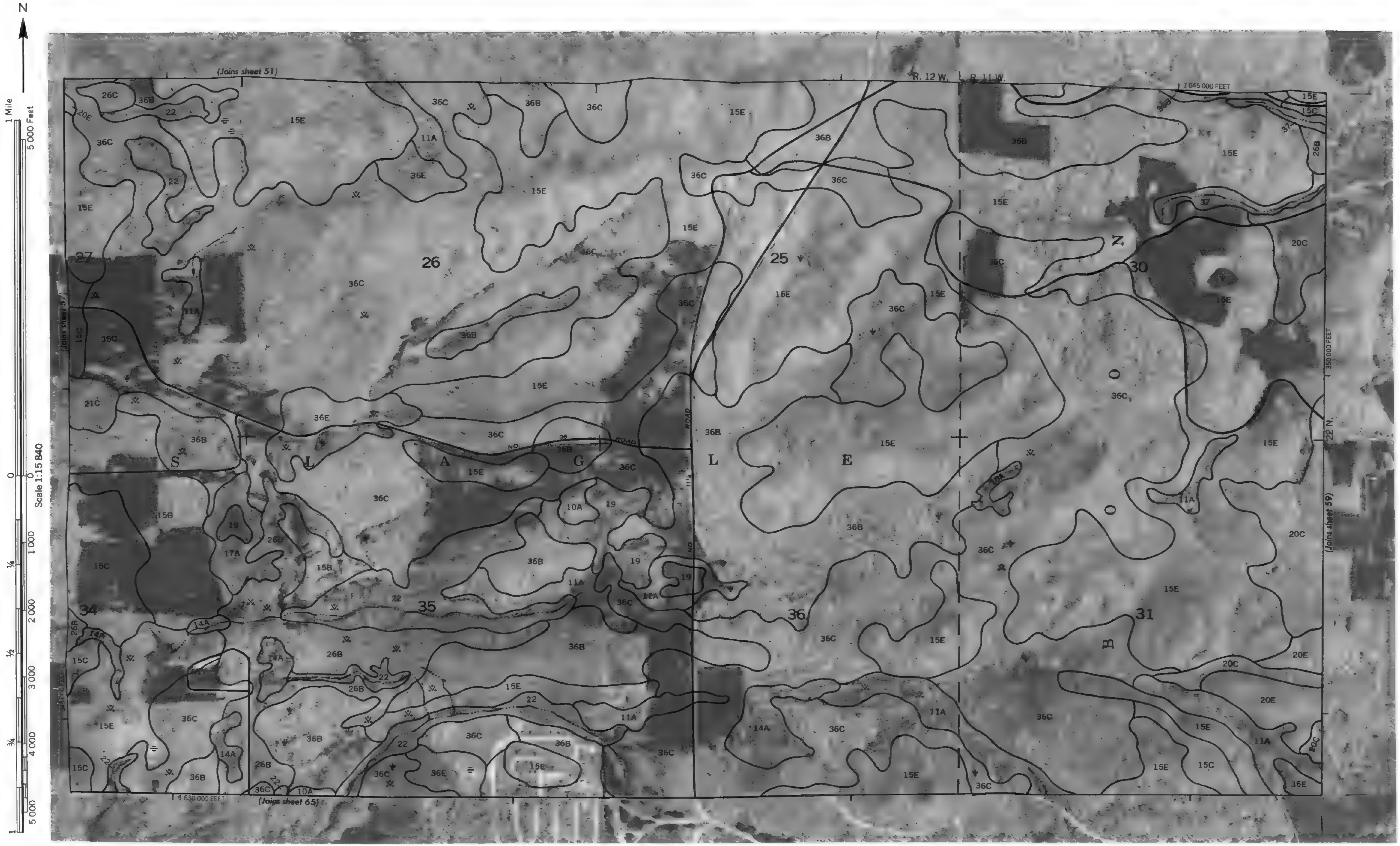
1 Mile

5 000 Feet

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 57

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 58



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 58

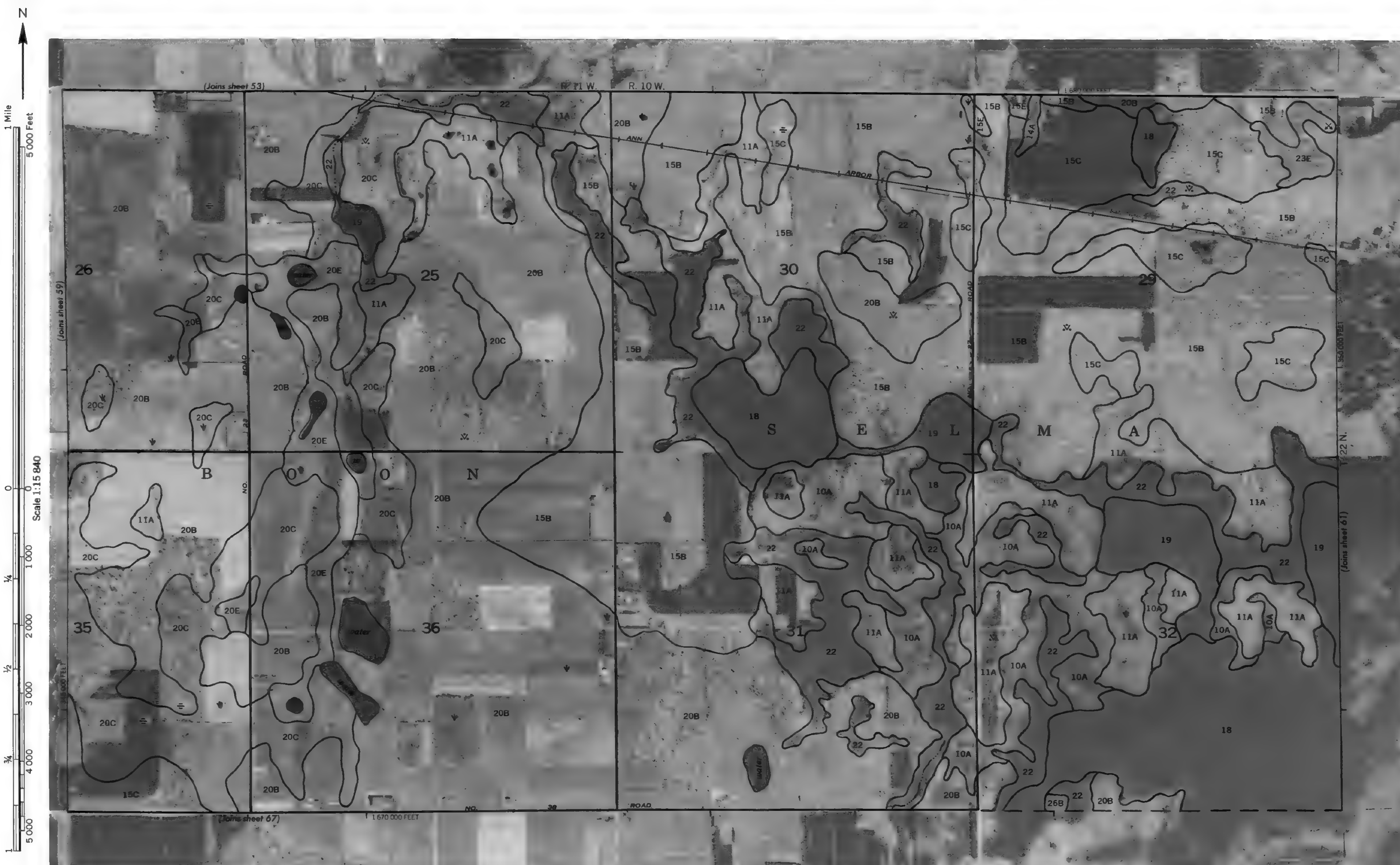
59

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 59

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

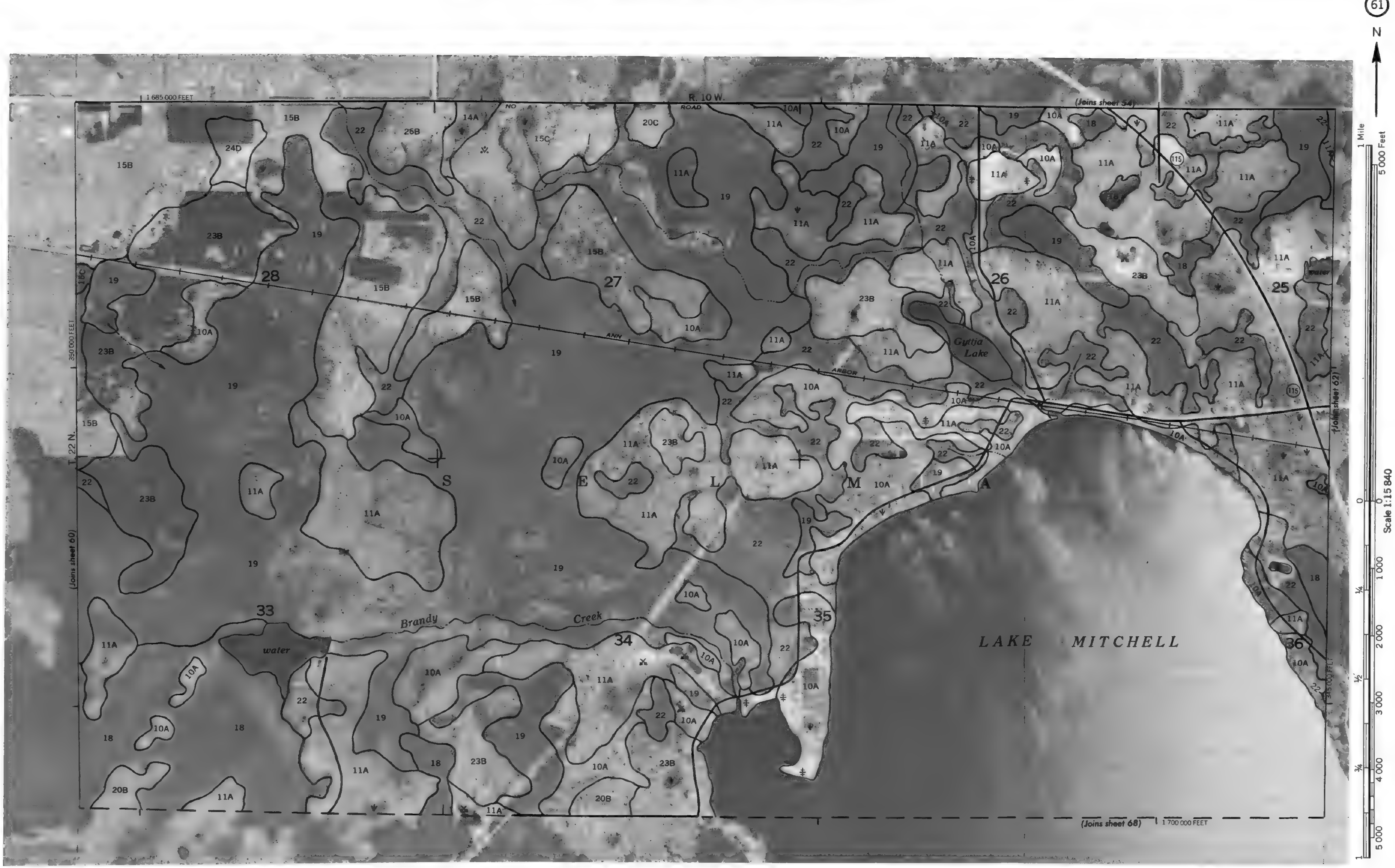
(60)

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 60



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 60



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 61

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

62

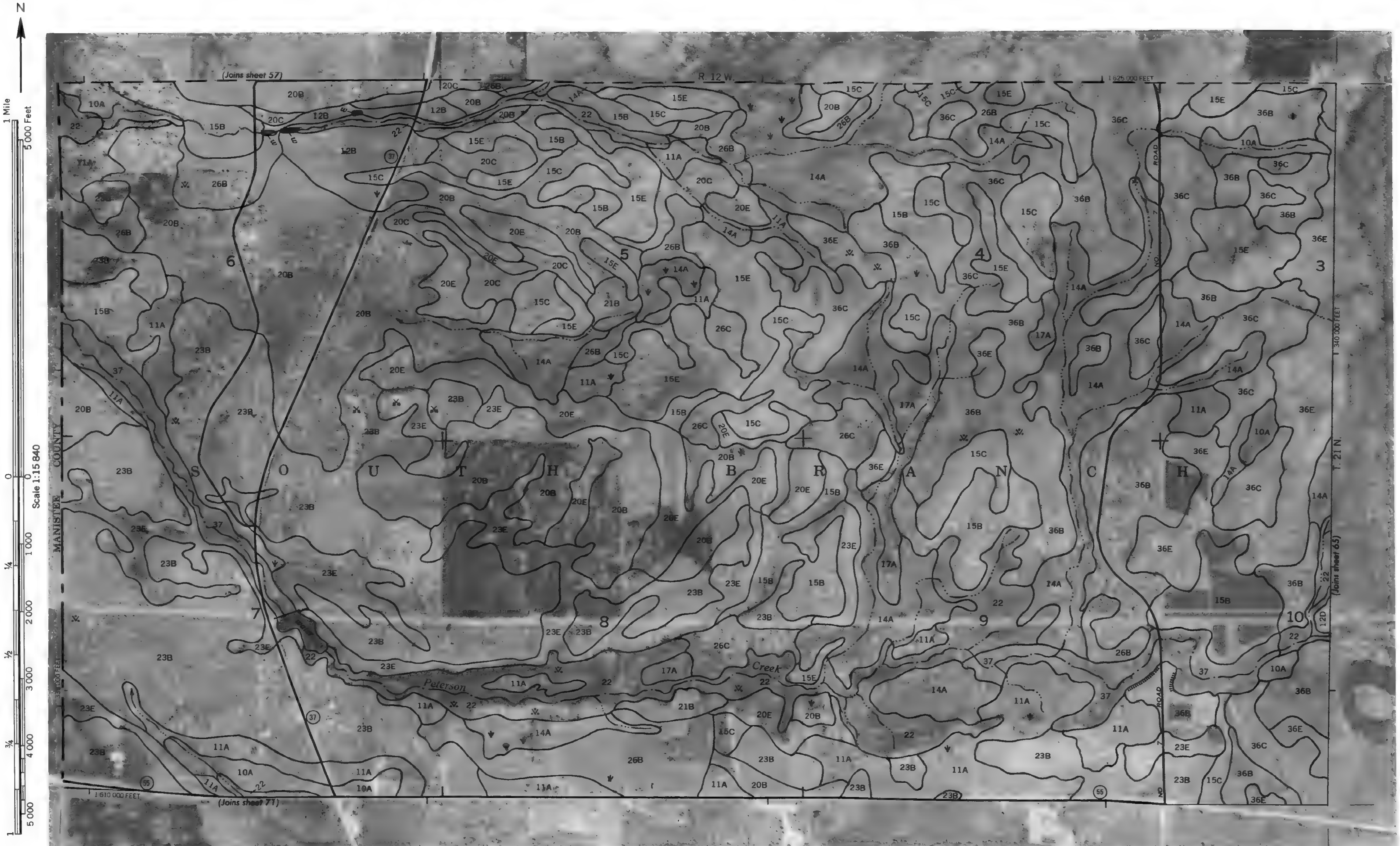
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 62

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 63

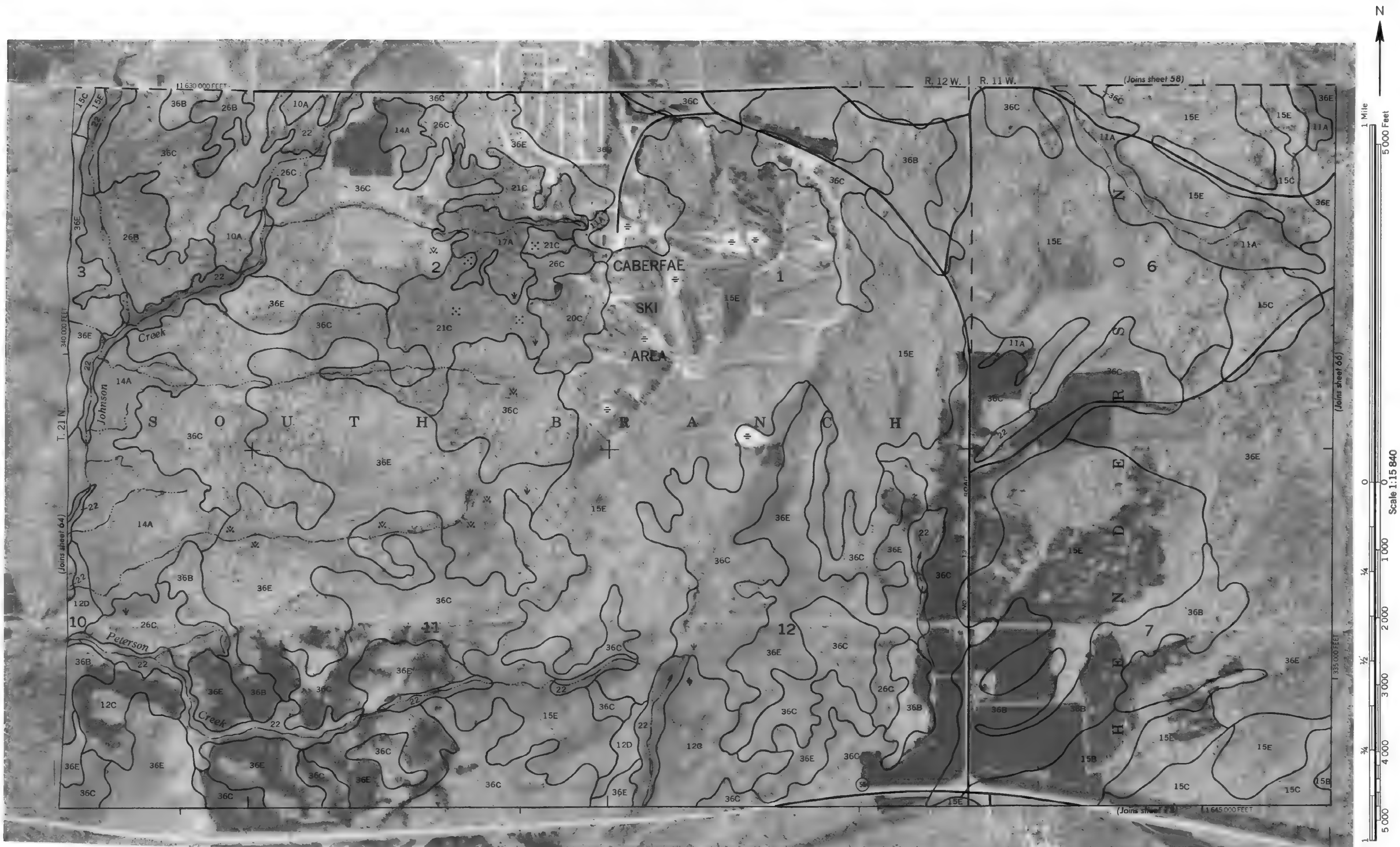
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN — SHEET NUMBER 64



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

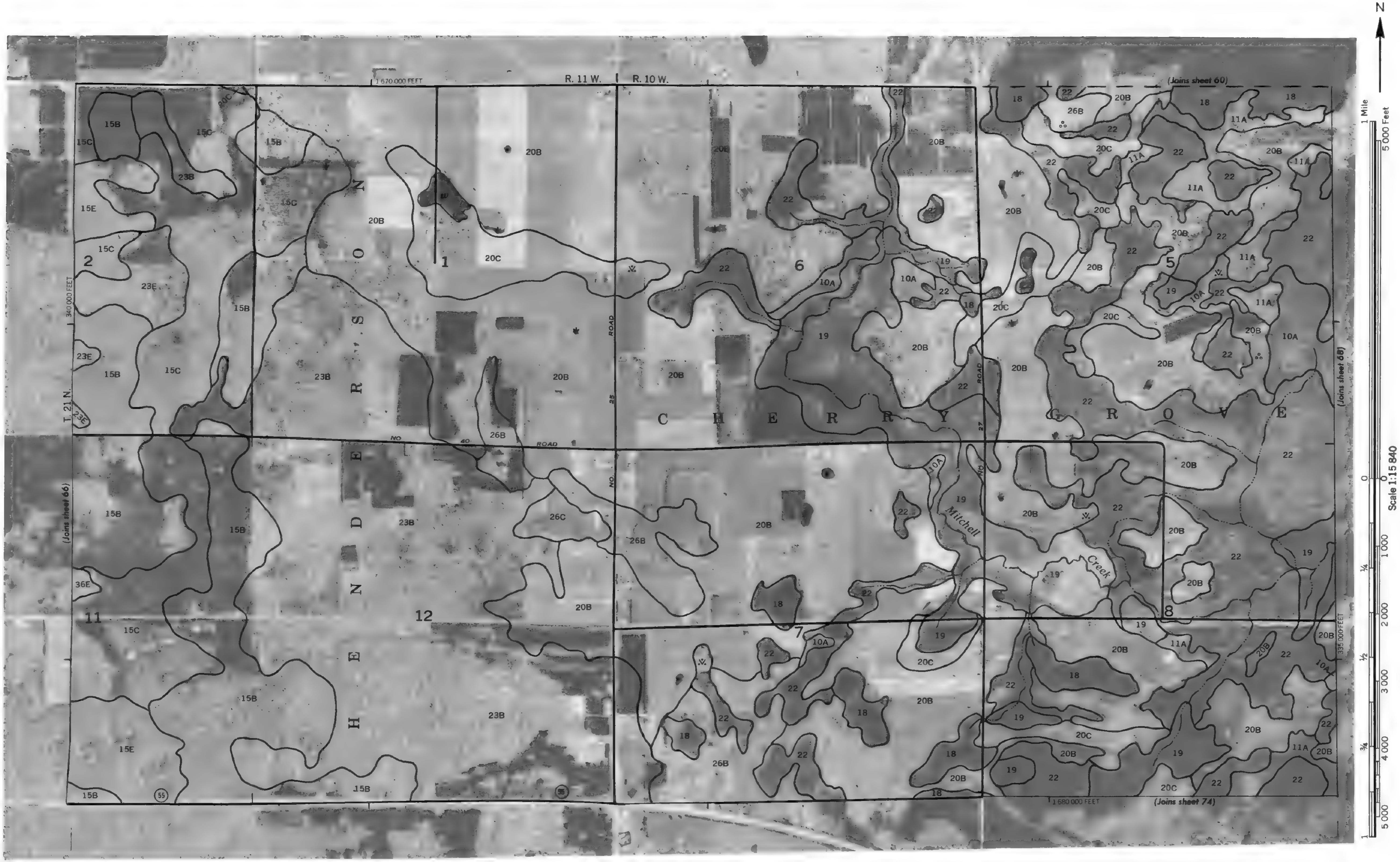
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 64



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 65

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


66
N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 59)
R. 11 W.
1 665 000 FEET
(Joins sheet 65)
(Joins sheet 67)
(Joins sheet 73)
1 650 000 FEET
335 000 FEET
340 000 FEET
T. 21 N.
H E N D E R S O N
NO. 40 ROAD
5
4
3
2
8
9
10
11
15C
15E
36E
10A
15B
36C
22
20E
23E
21C
24D
26C



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 67

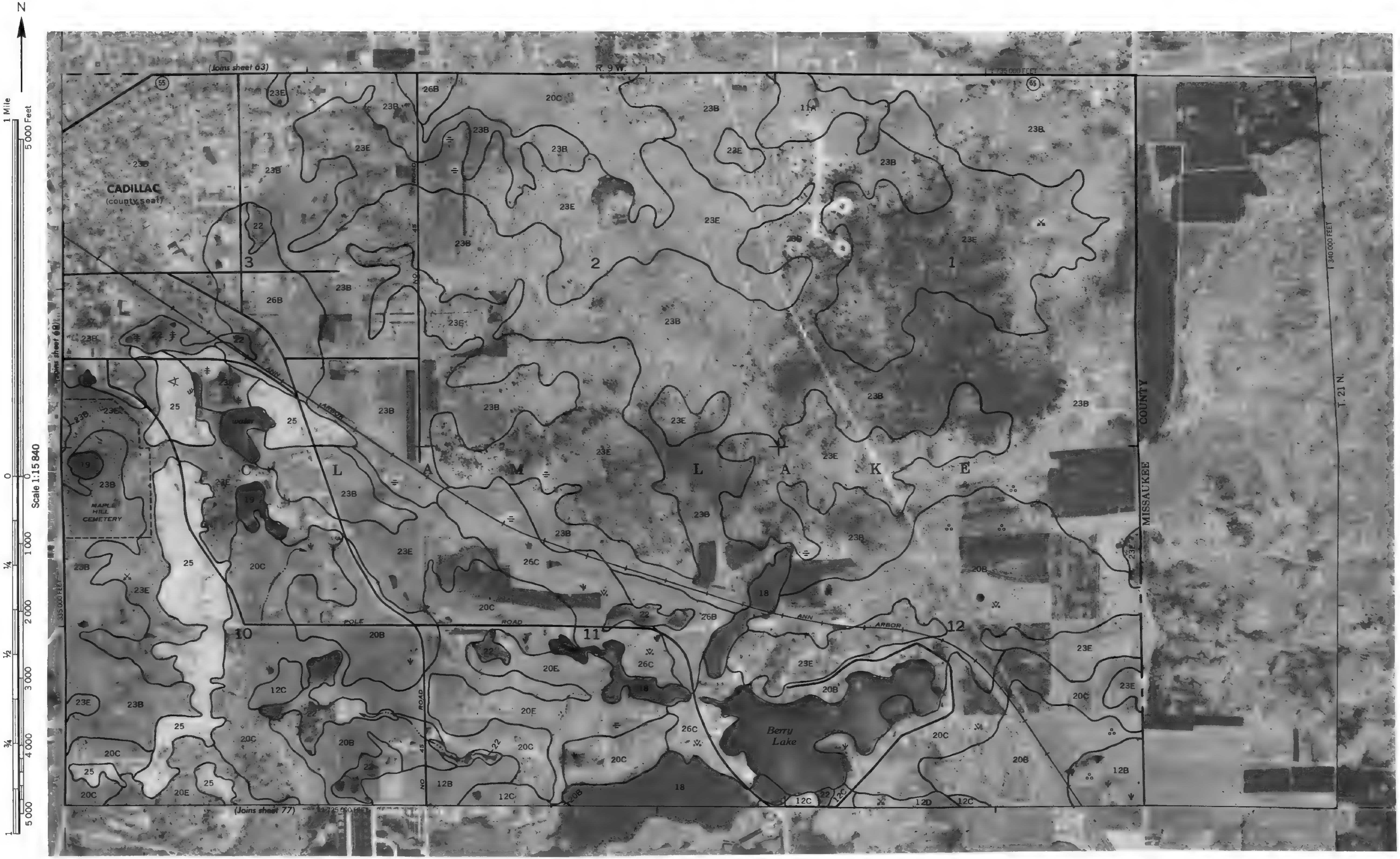
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 68

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 69

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 70

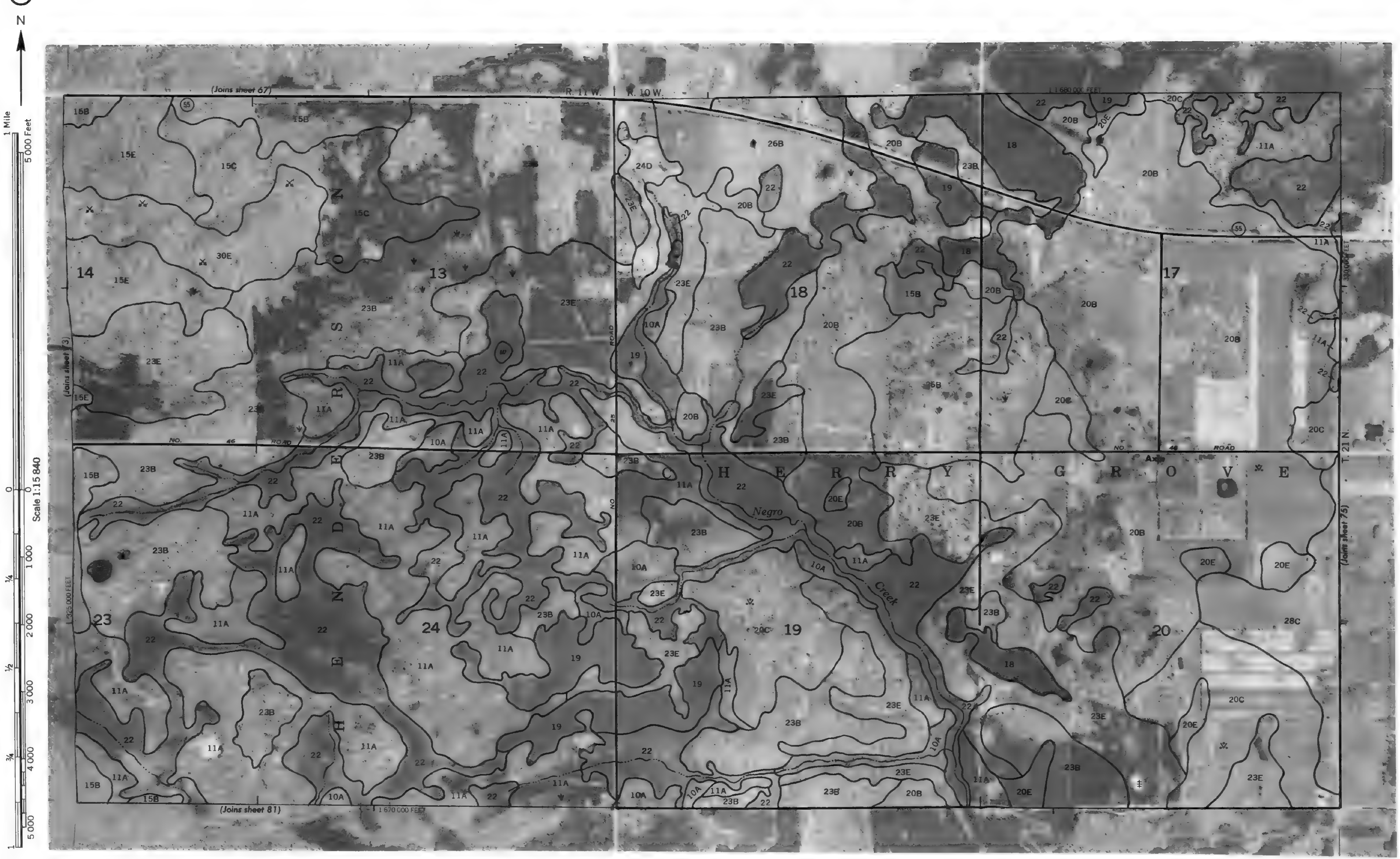
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 71

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

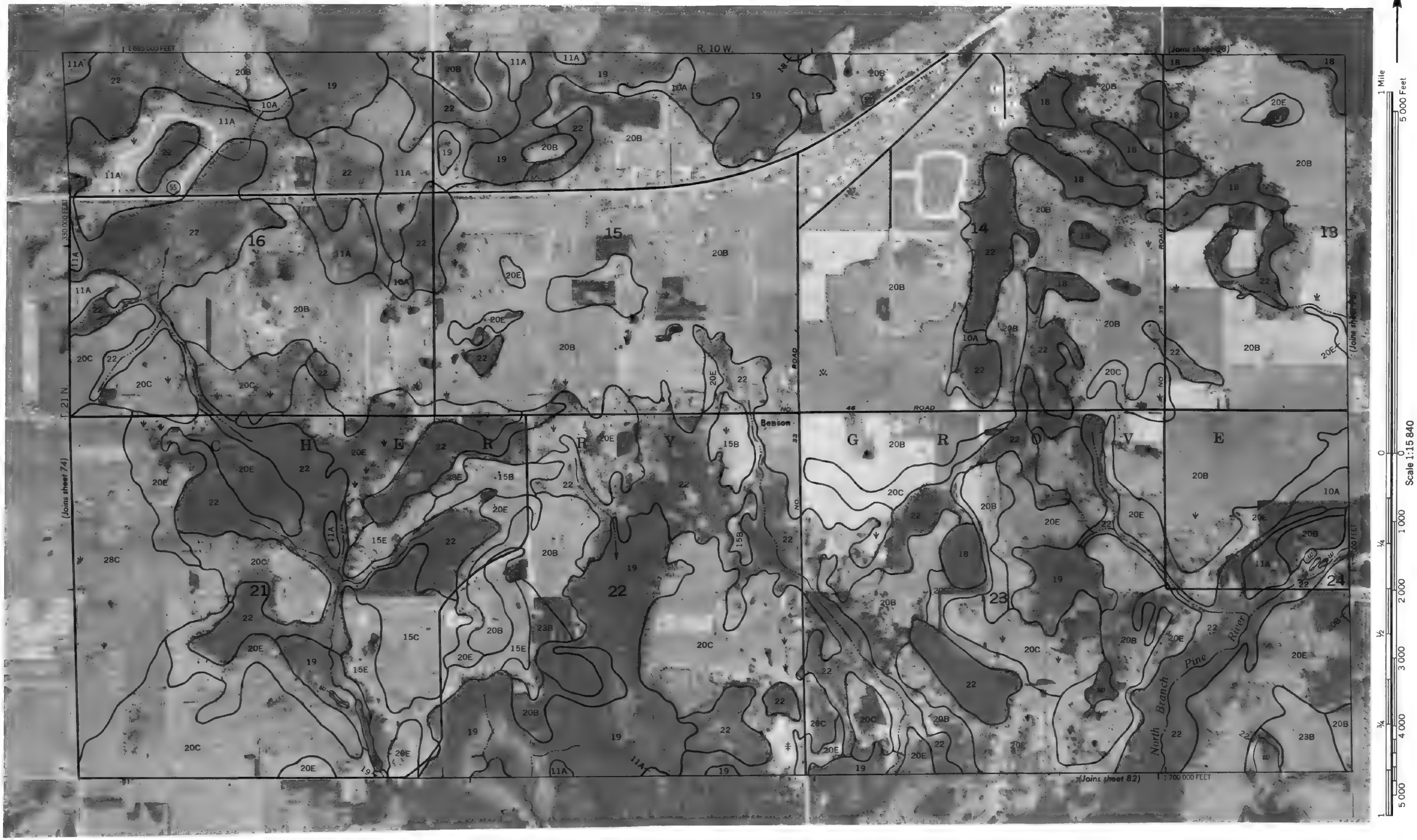
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 73

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



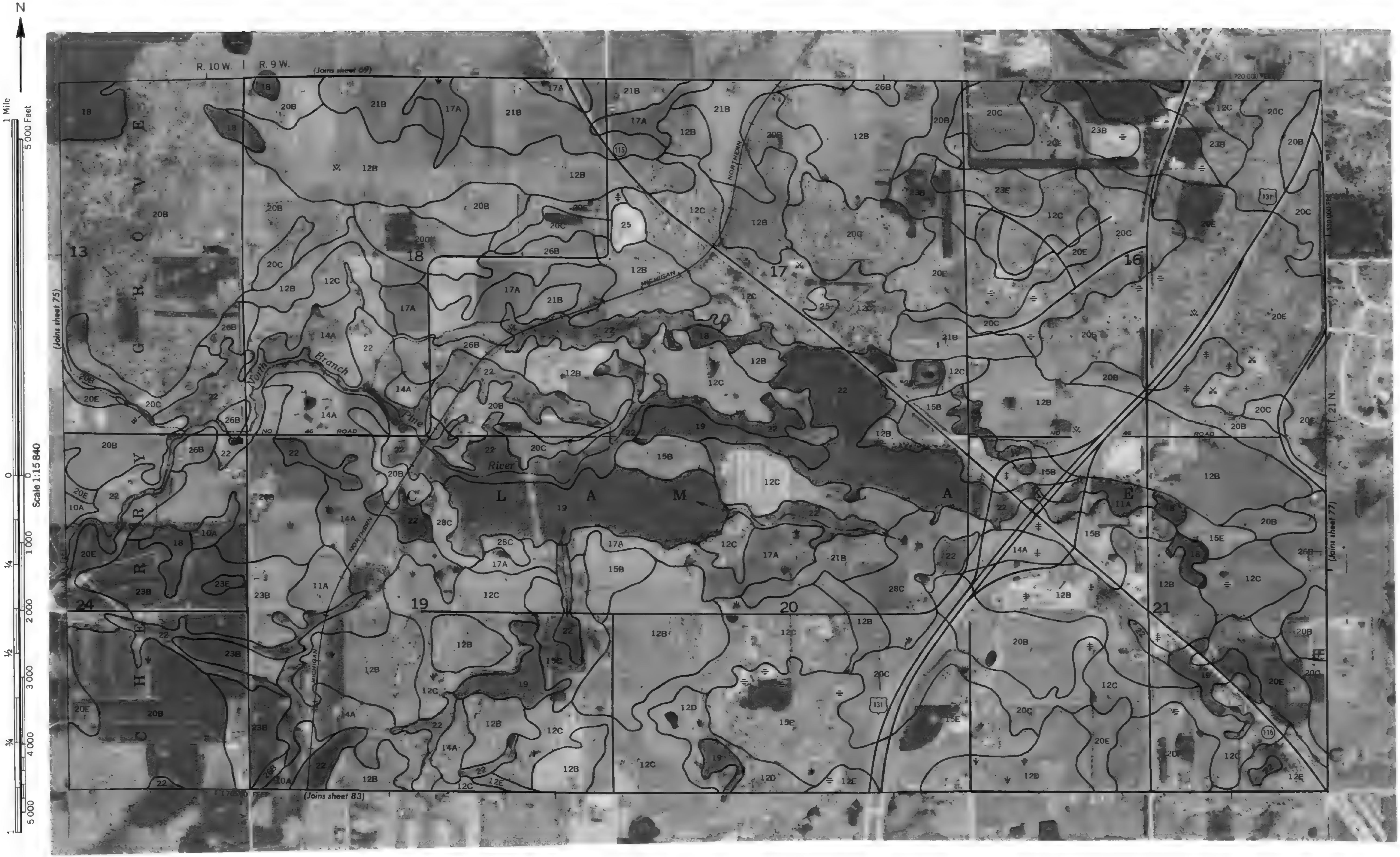
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 74



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 75

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

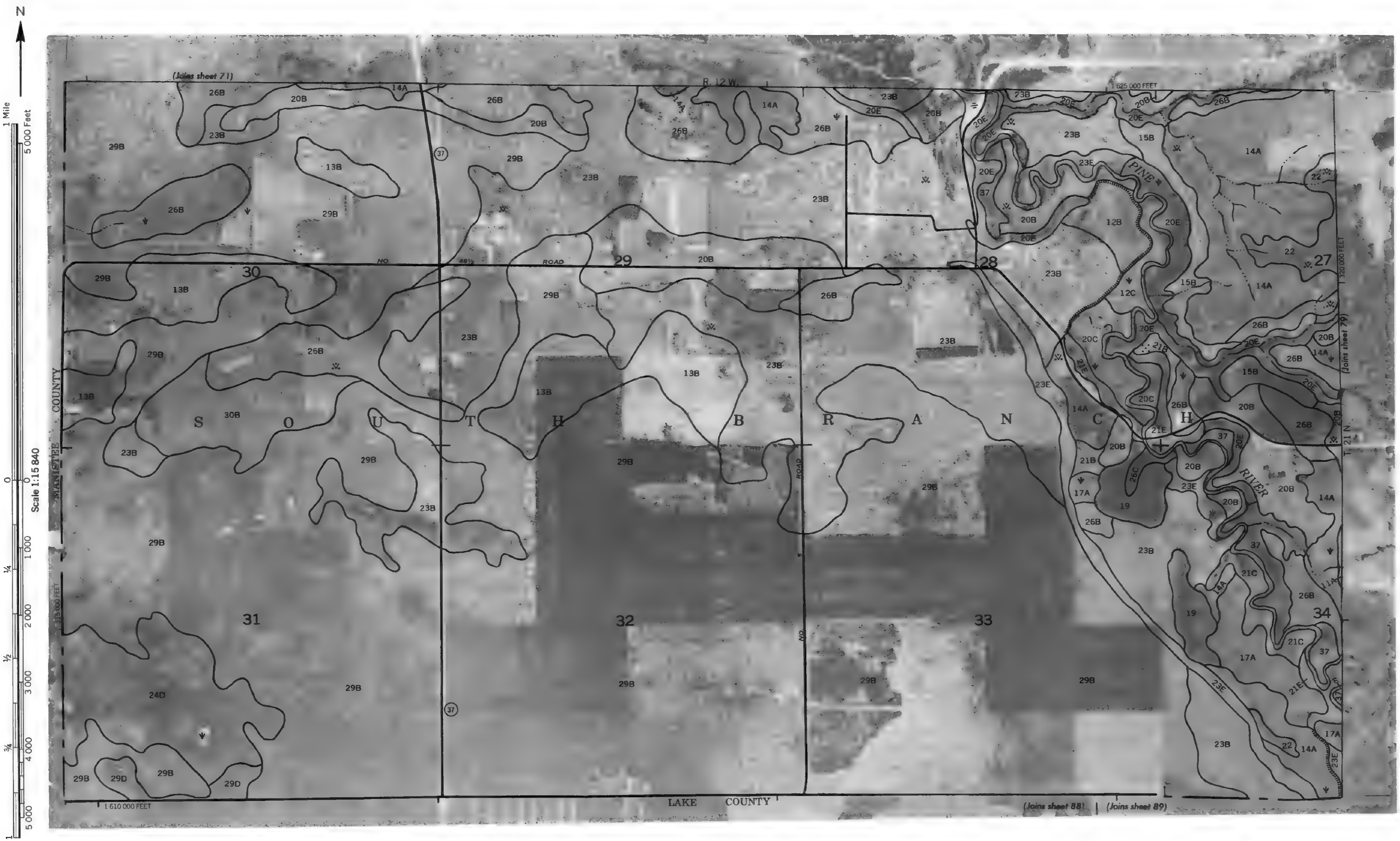


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 76

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 77

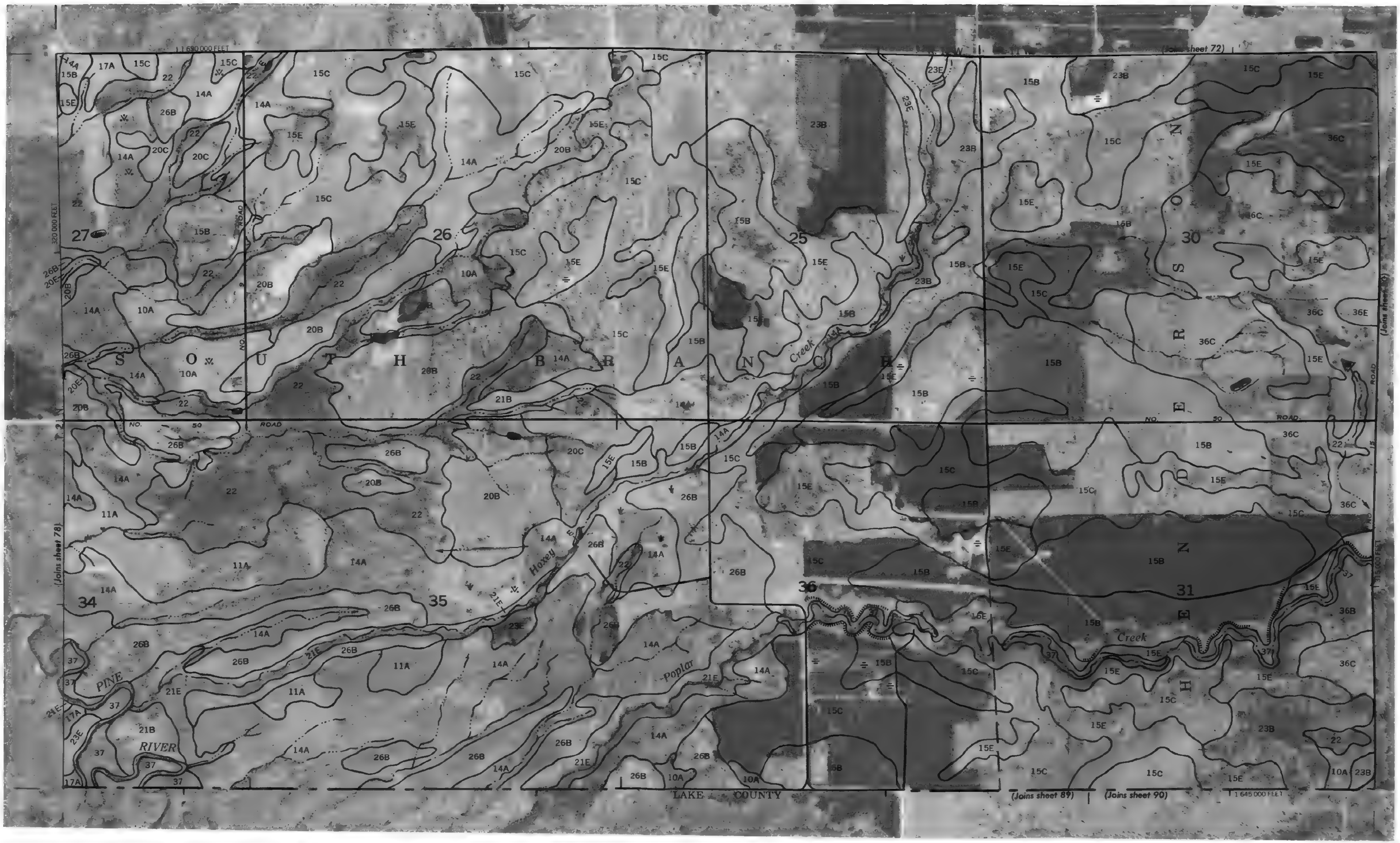
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned

79

N



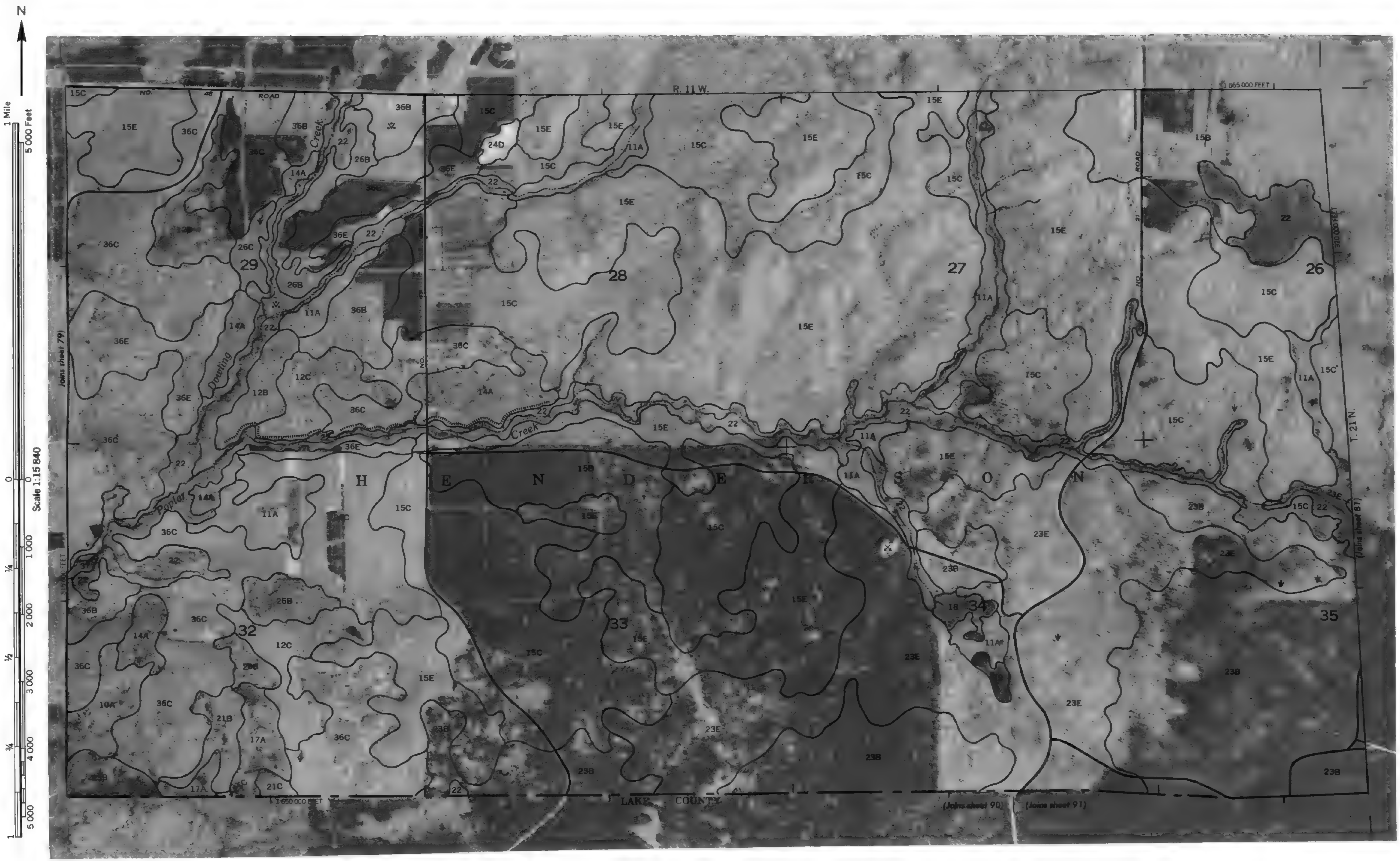
Scale 1:15 840

1 Mile
5 000 Feet

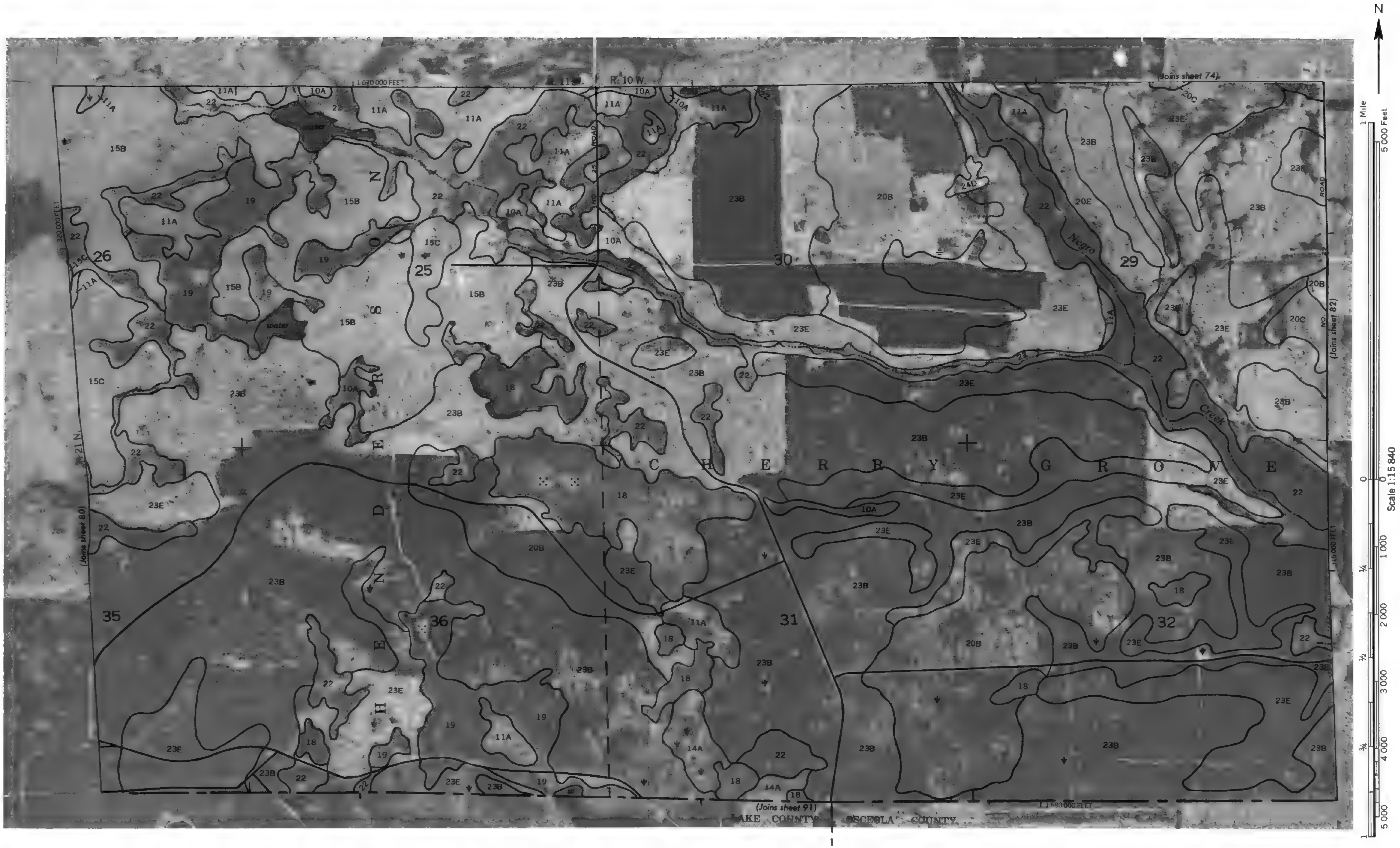
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 79

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(80)



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



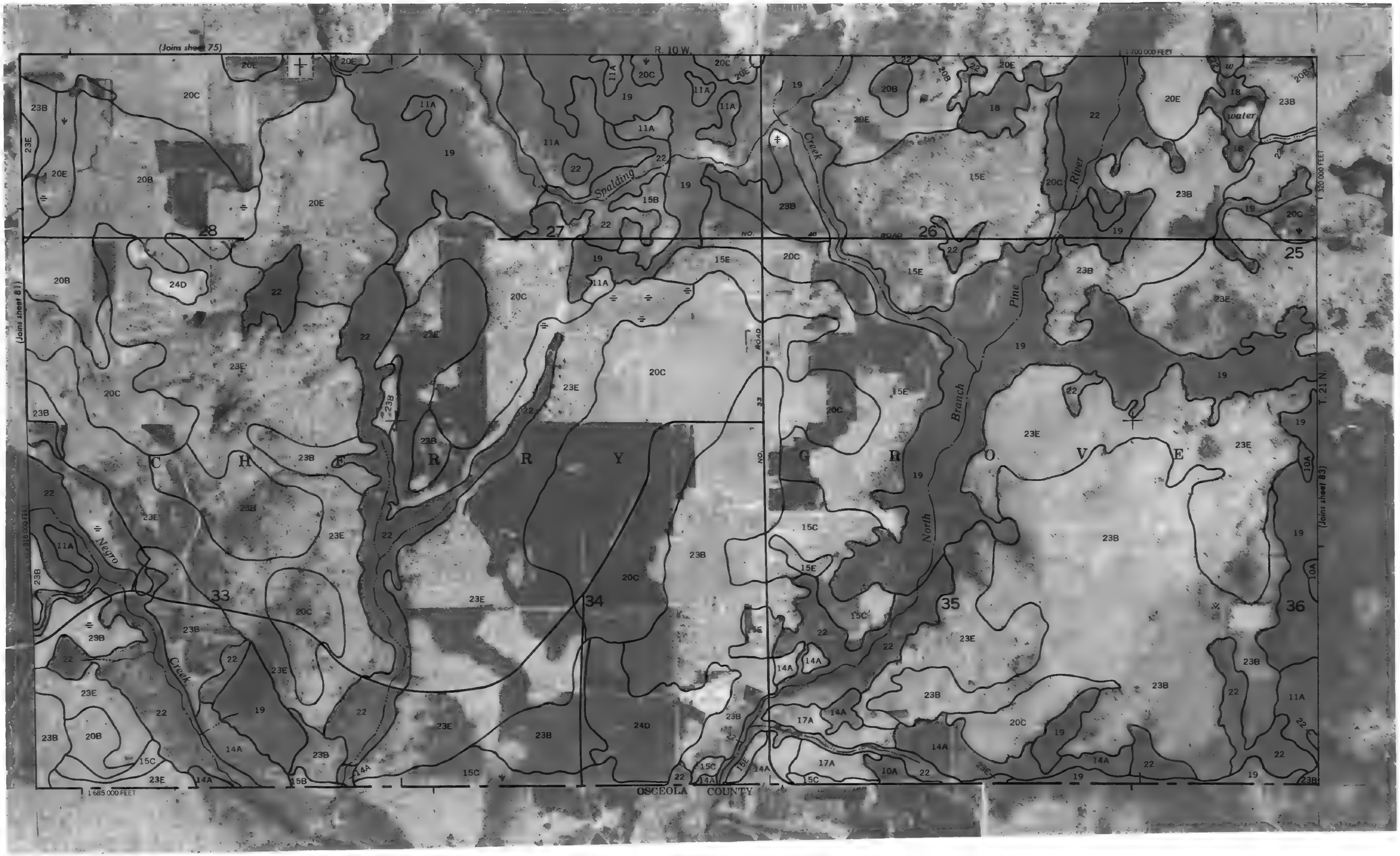
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 81

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land divisions on corners, if shown, are approximately positioned.

82

N

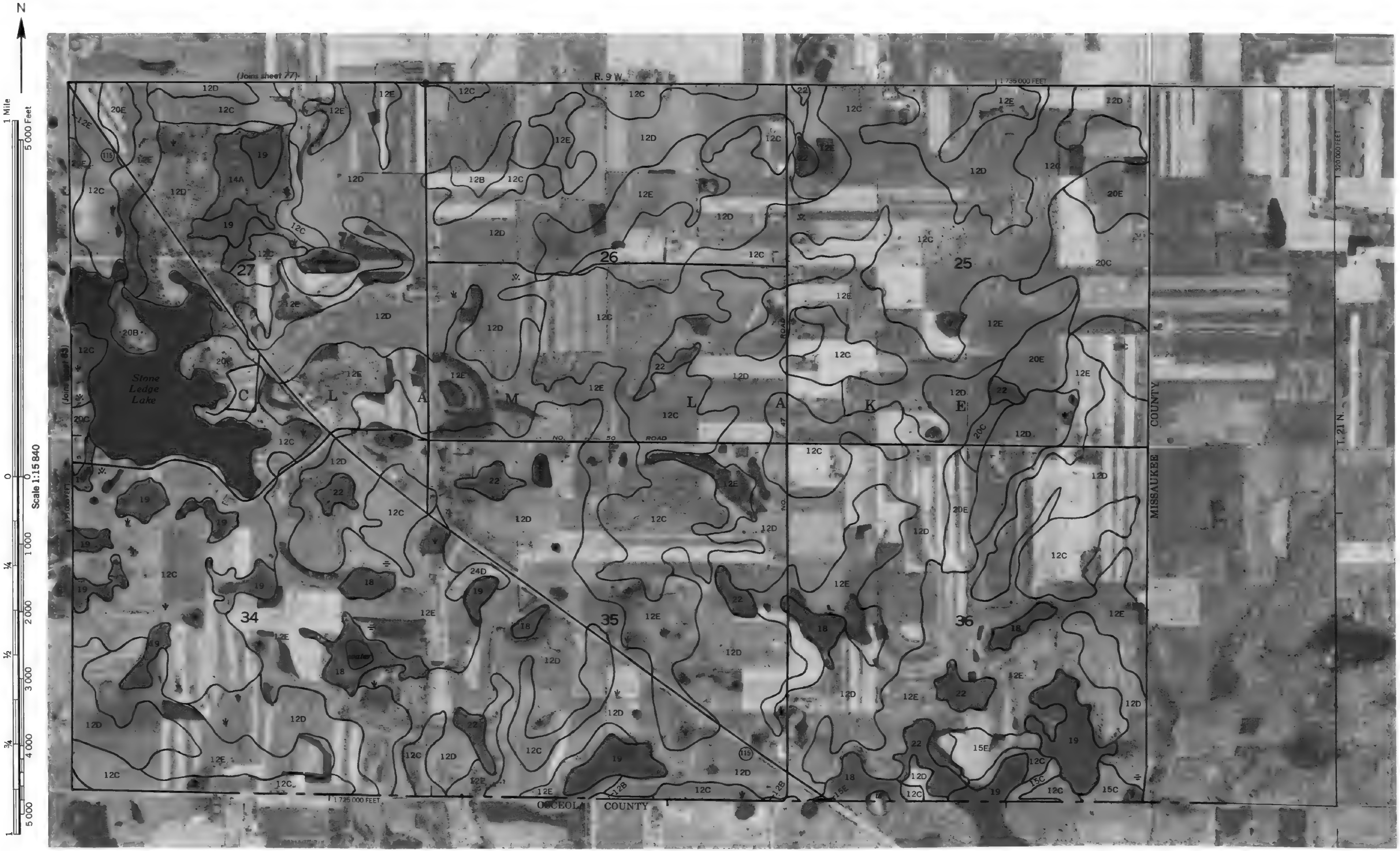
1 Mile
5 000 Feet
Scale 1:15 840



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 83

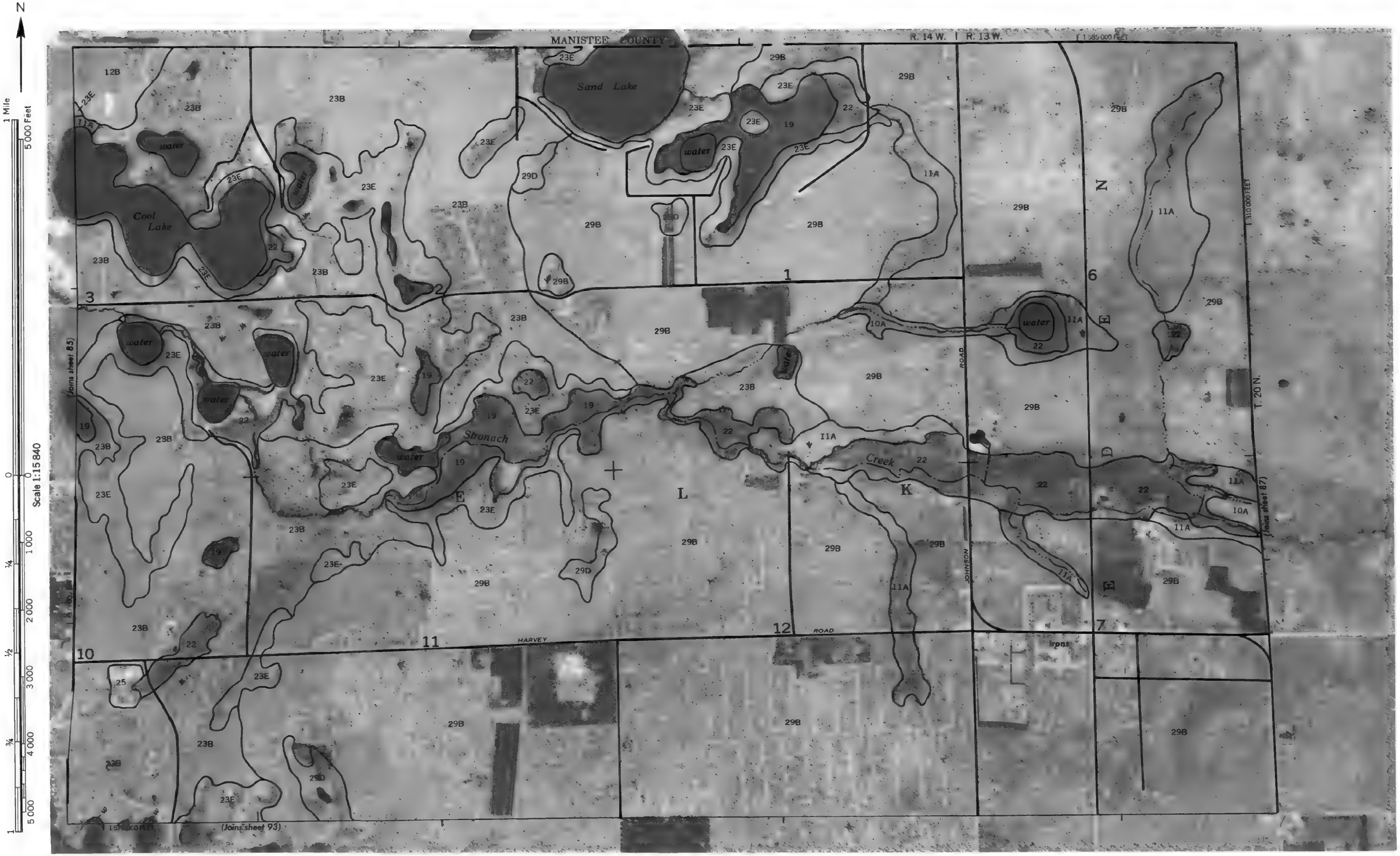
This map is compiled on 1978 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 84

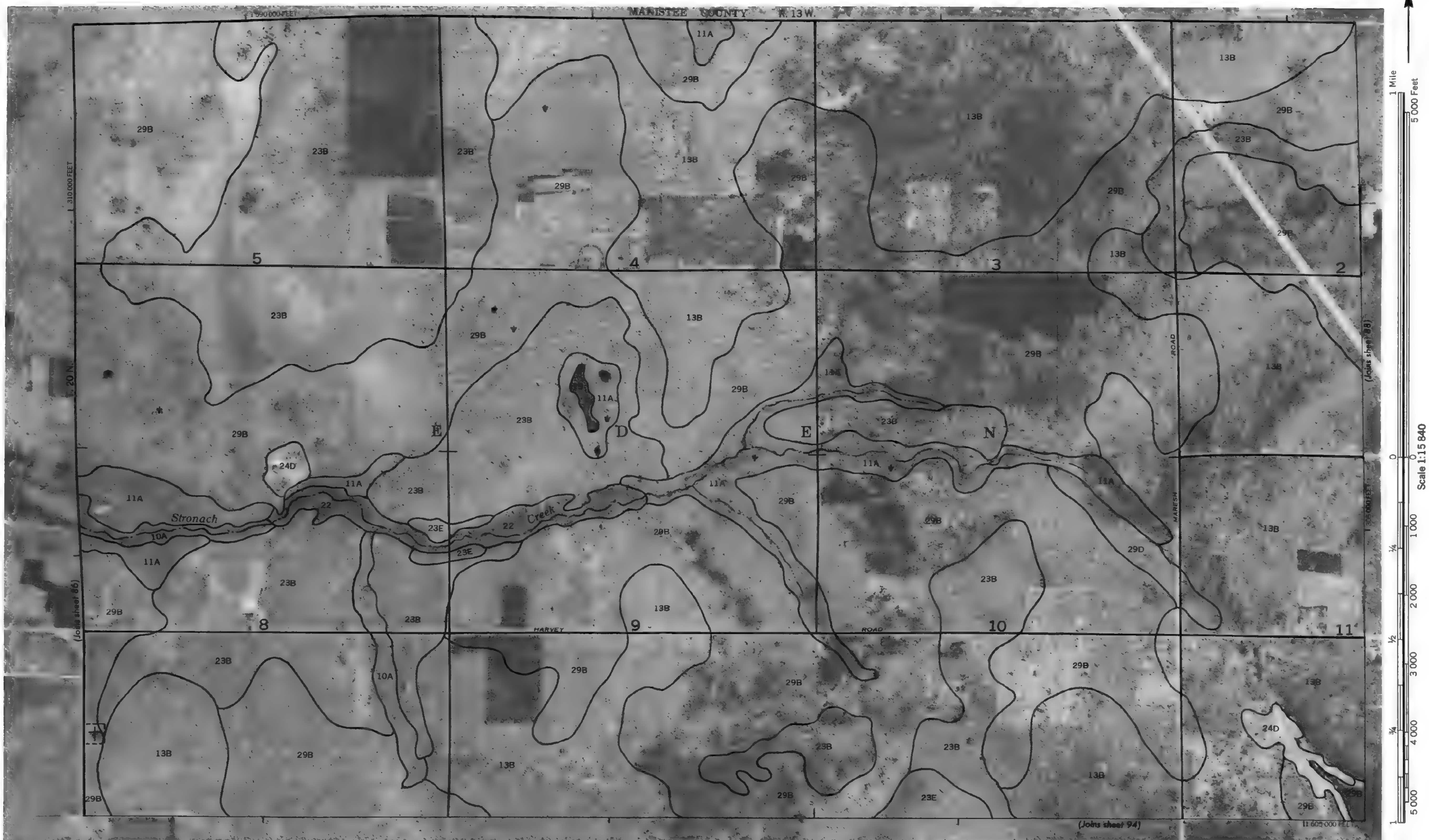
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

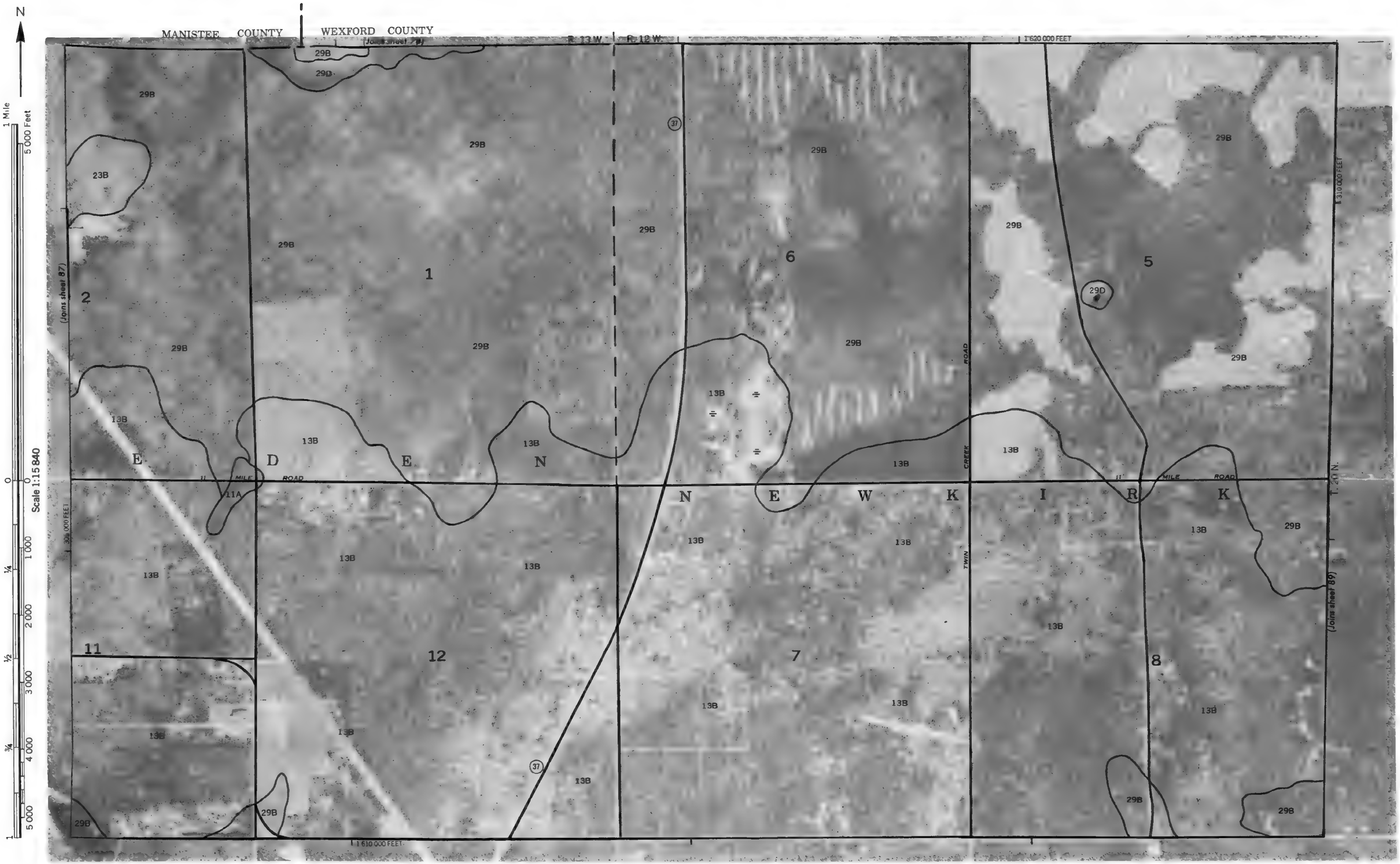


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 87

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

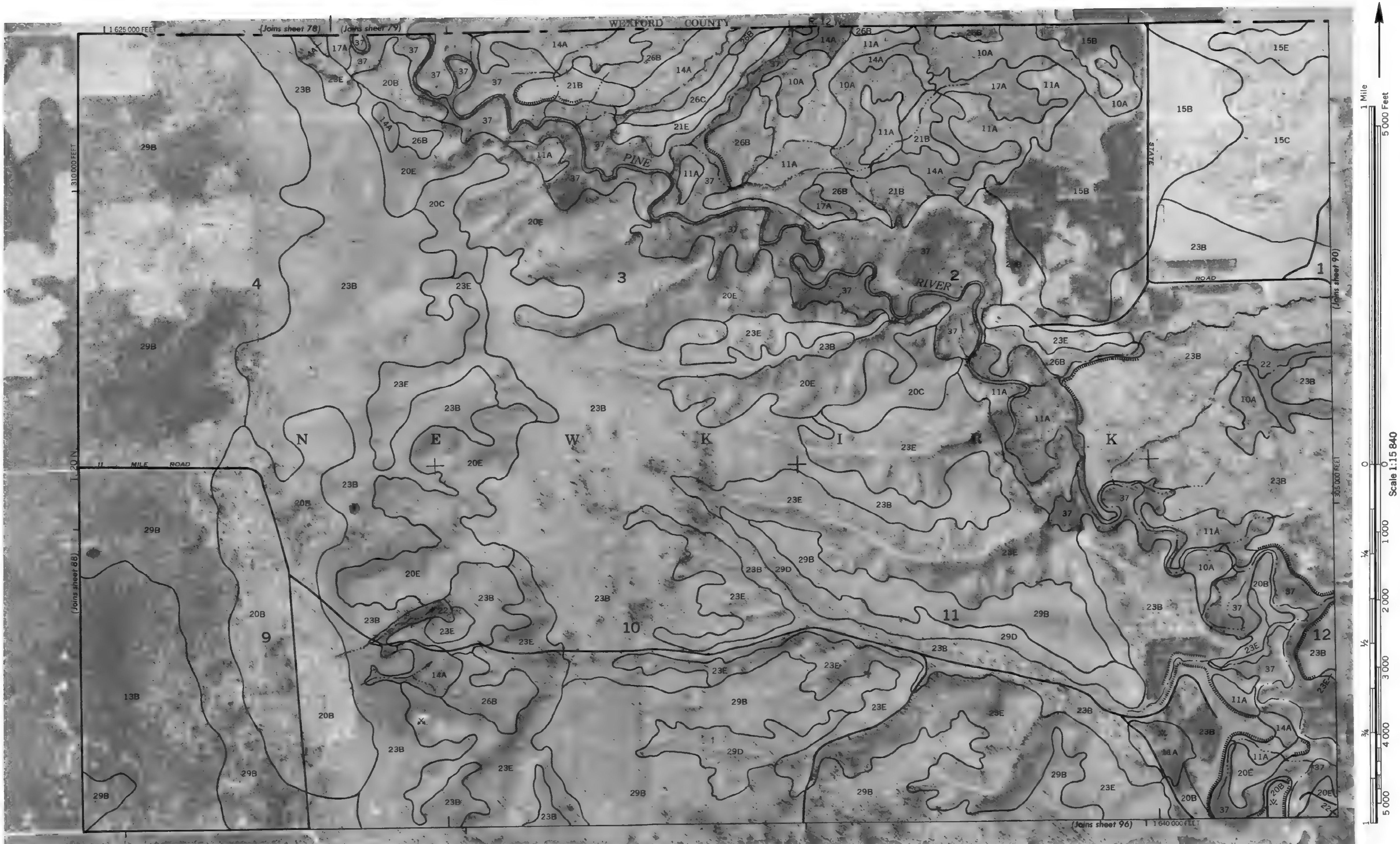


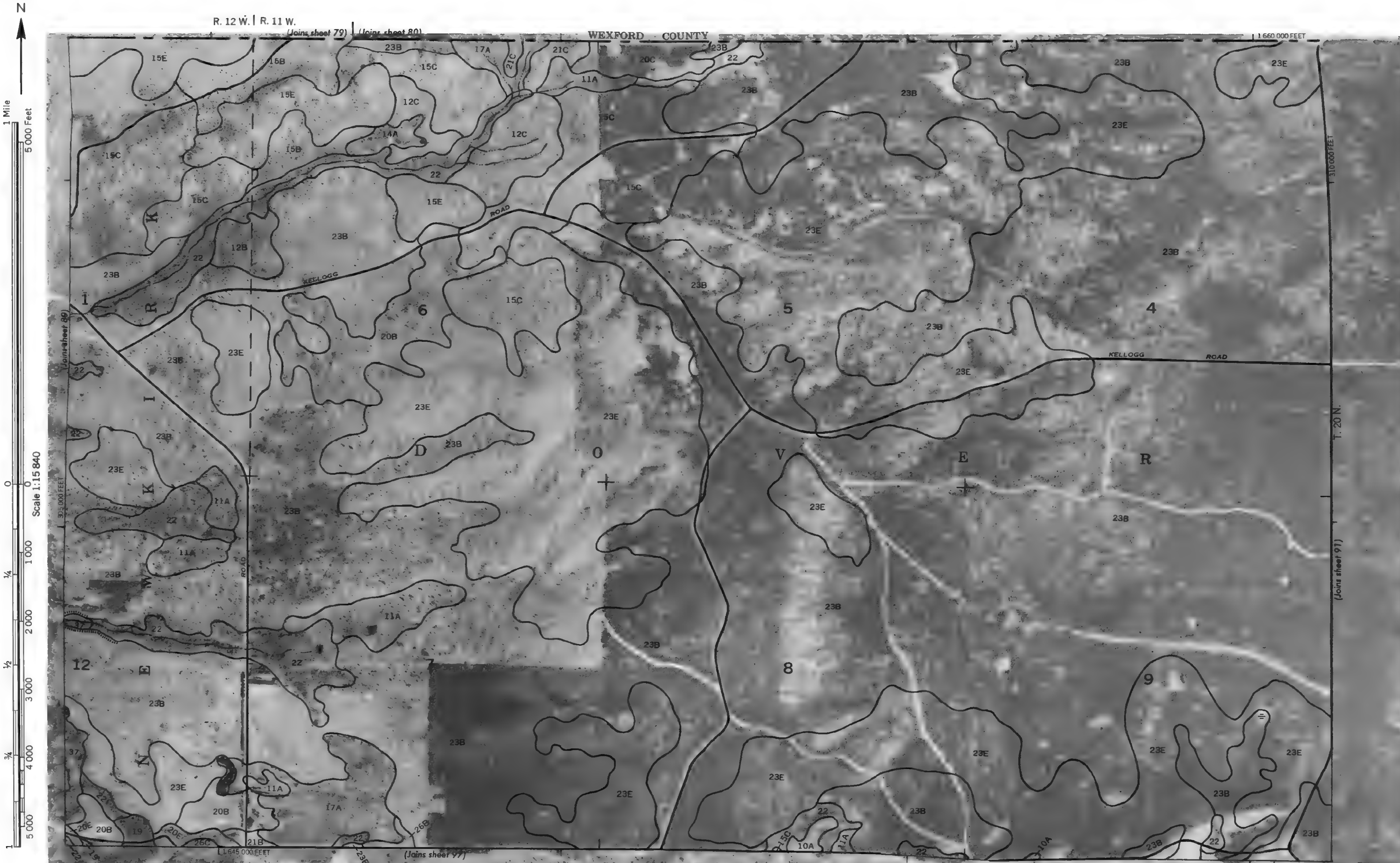


This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 89

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

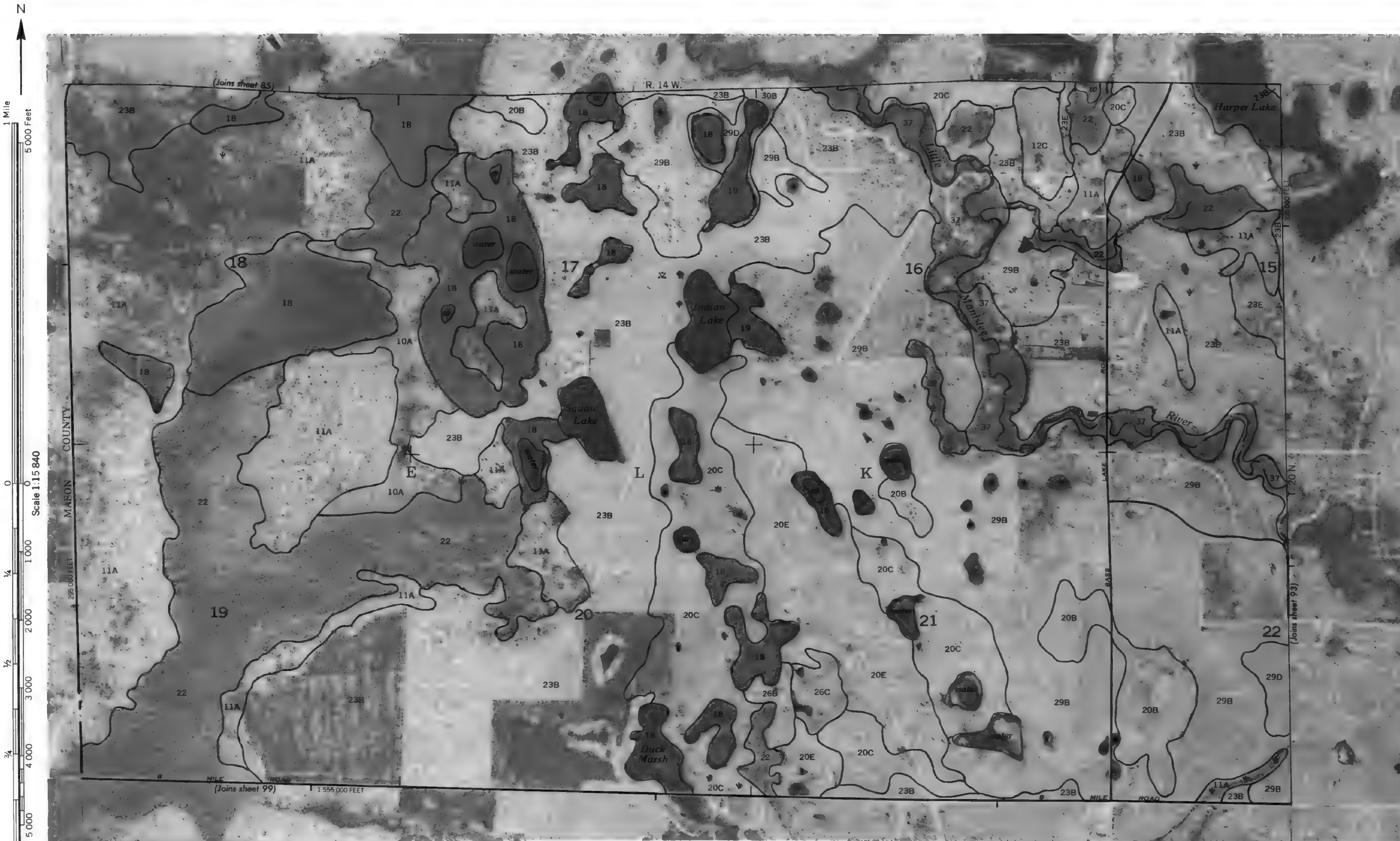




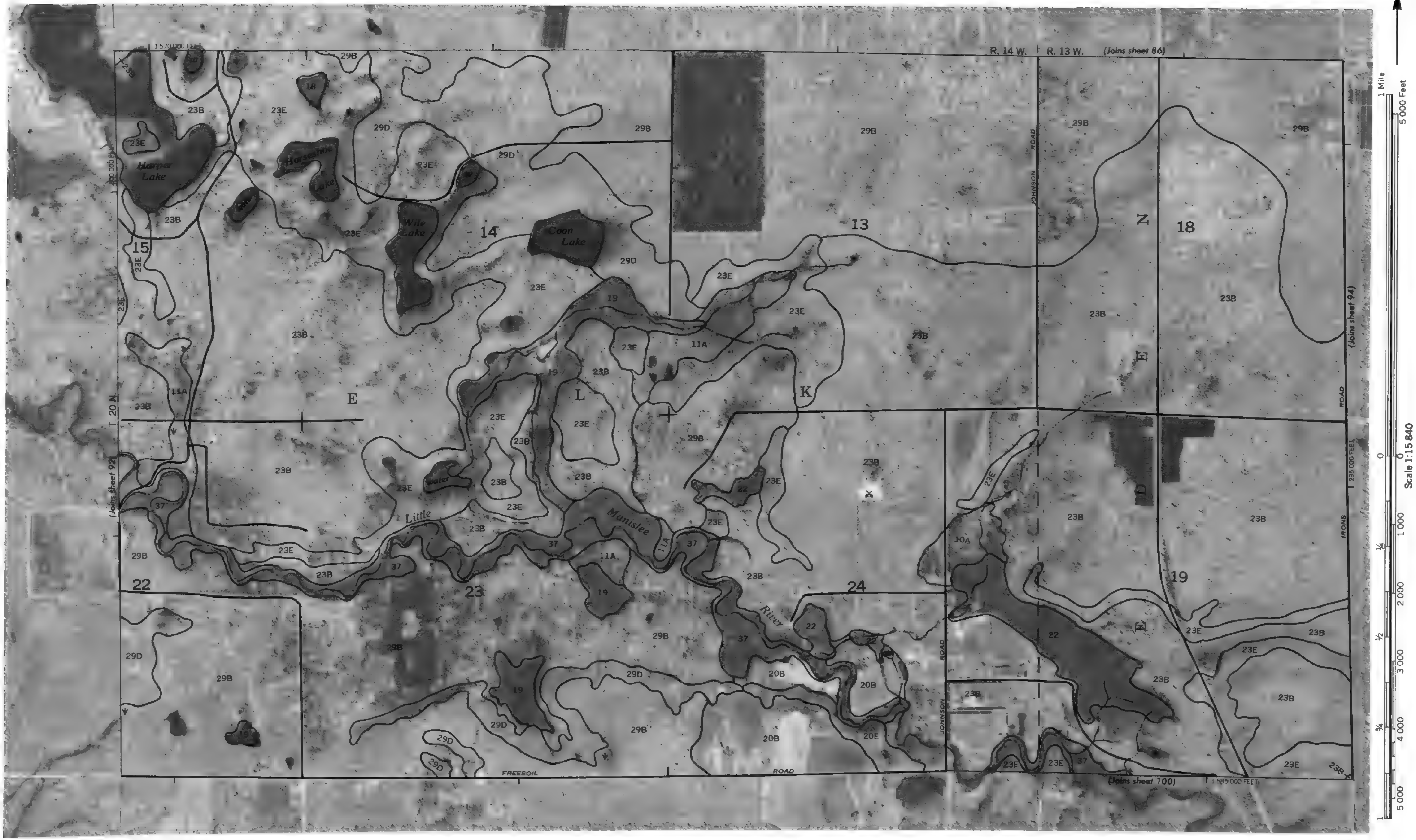
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 91

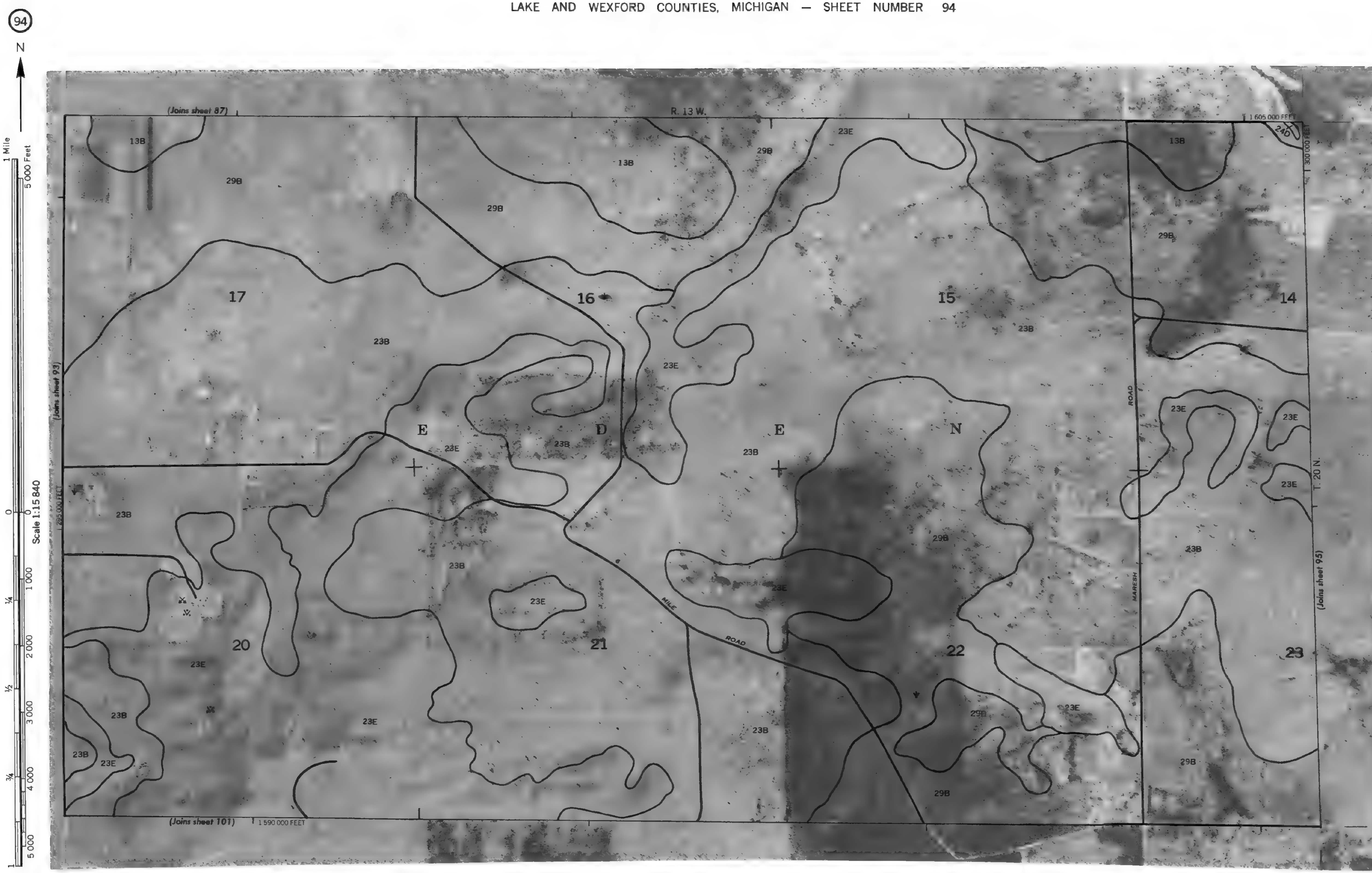
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land divisions corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

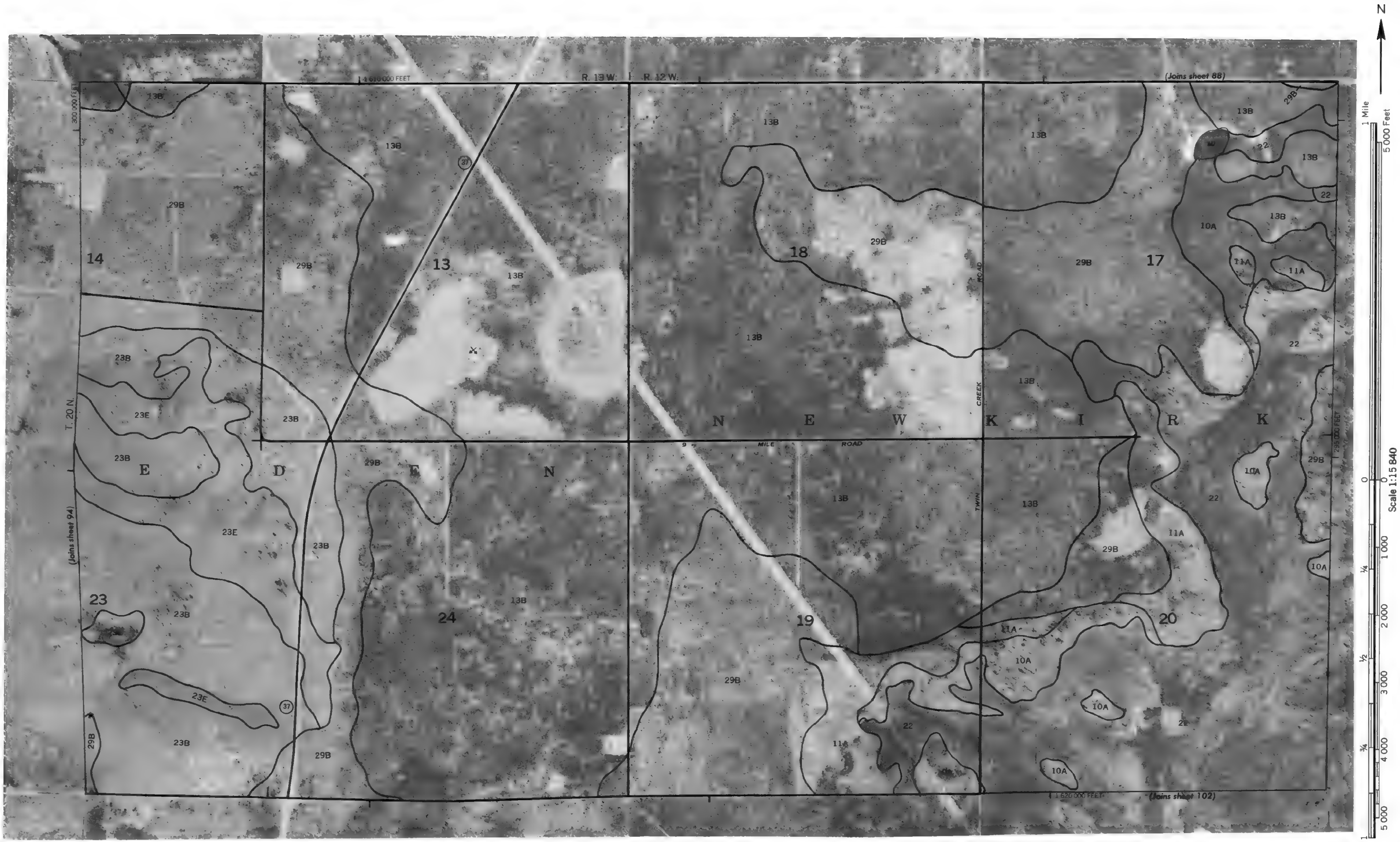


LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 93
This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

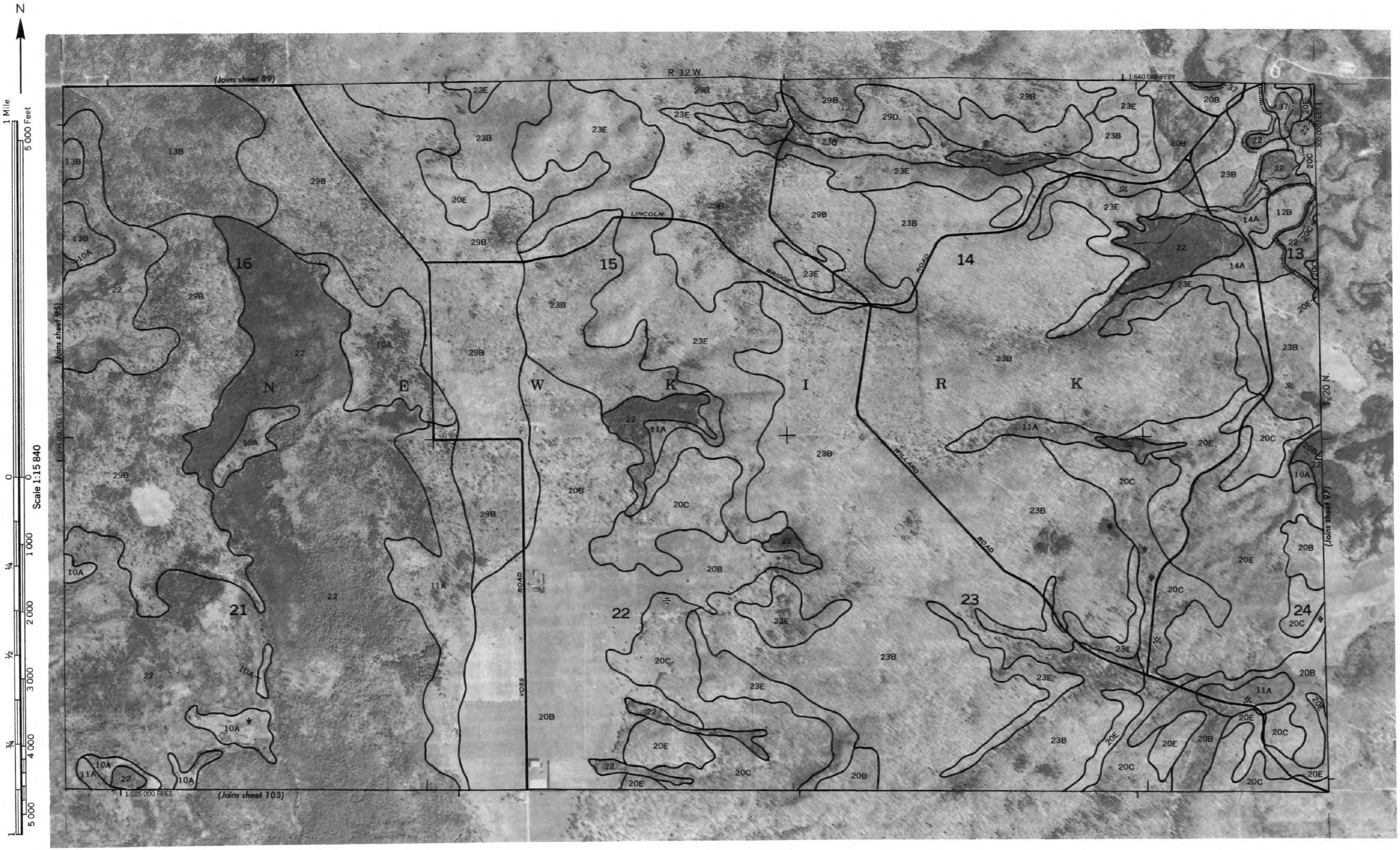
LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 94



LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 95

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

96



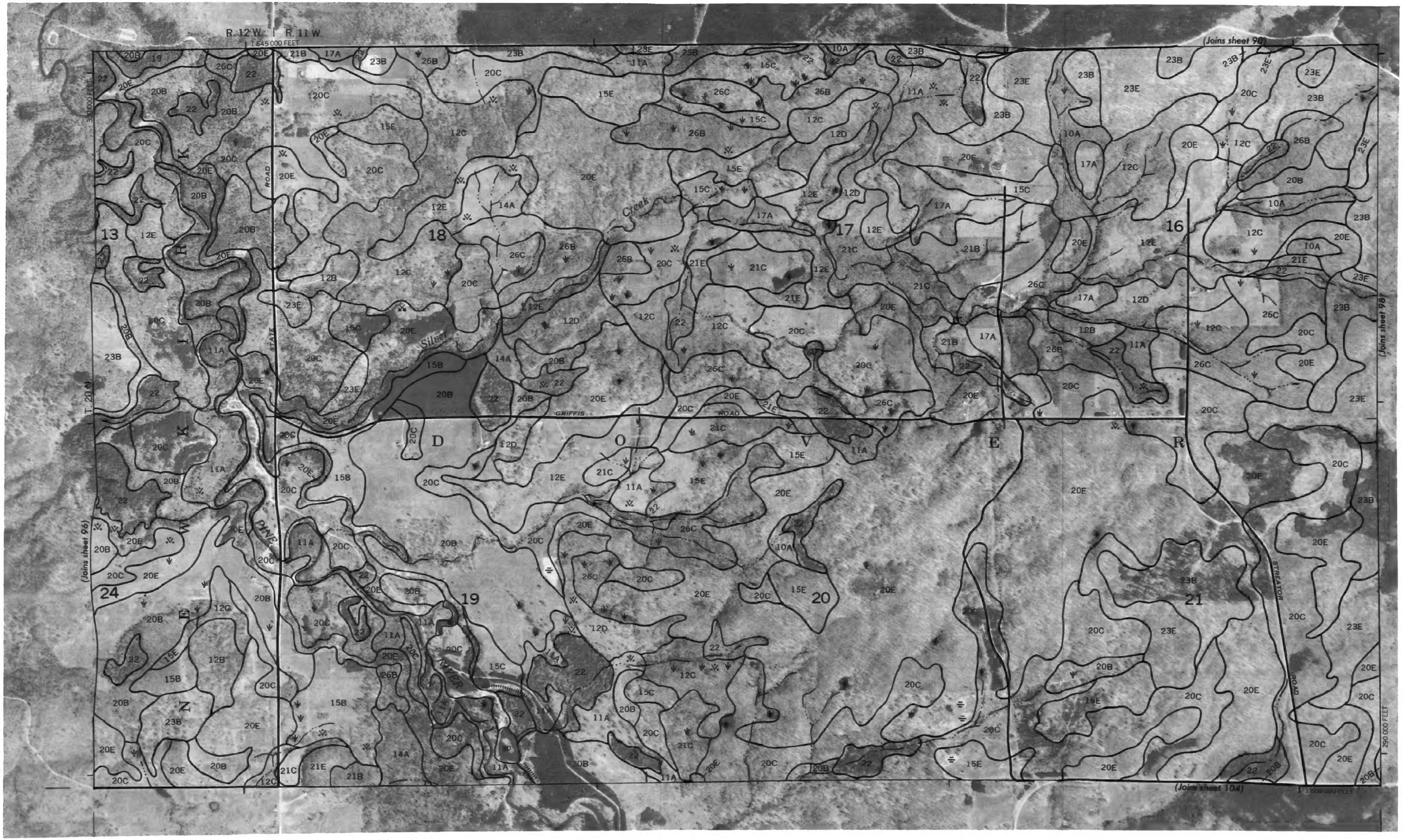
This map is compiled on 1976 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 96

(97)

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 97

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



N

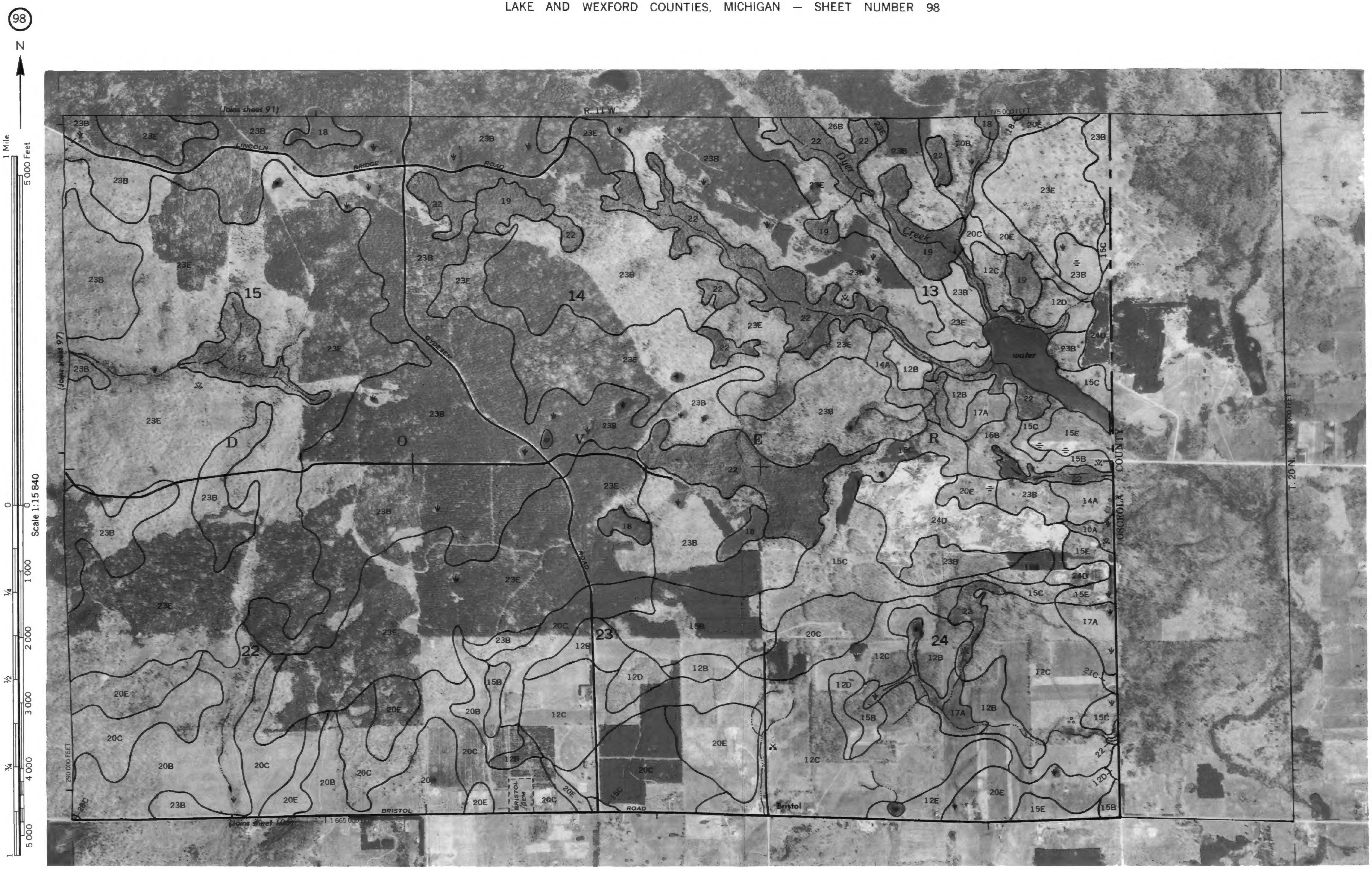
1 Mile

5 000 Feet

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

Scale 1:15 840



This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 98

LAKE AND WEXFORD COUNTIES, MICHIGAN NO. 99

This map is compiled on 1976 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.